INTEGRATED EDITION OF THE PETROLEUM ENGINEER

the Petroleum Engineer

FOR MANAGEMENT

AUGUST, 1958

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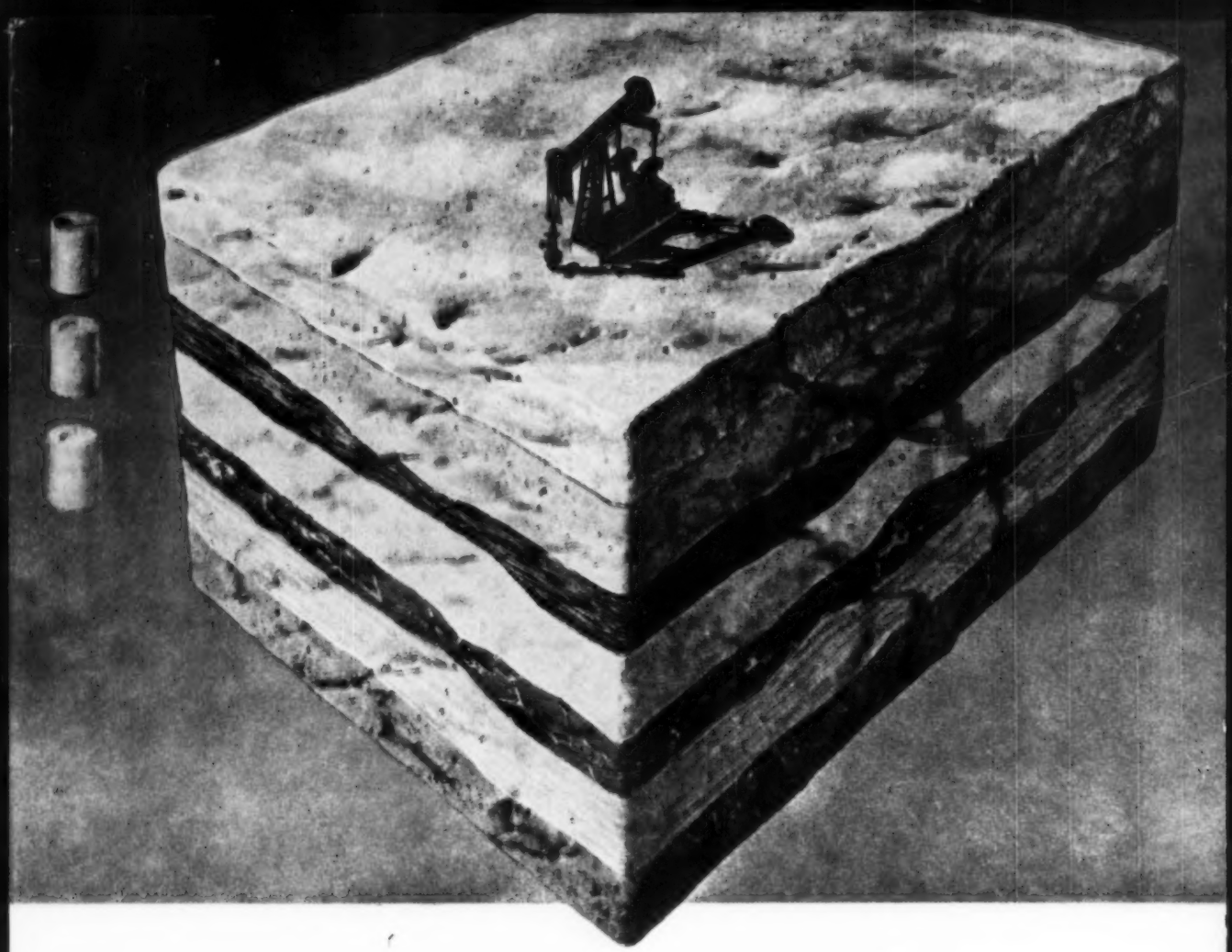

Could this be your marginal well?

If you're operating a marginal well, this illustration could be a portrait of that well. Close examination of your well logs may reveal additional zones of potential productivity and a chance for increased production—with the *right* acidizing or fracturing treatment.

Here, for example, are three adjacent oil-saturated intervals within a single section. They have dissimilar porosities, permeabilities, and acid solubilities. Production from any *one* interval would not pay out; from *two* would be marginal, but from *all three* would make a good commercial well.

The problem is to devise a treatment, economically feasible, that would stimulate all three intervals to maximum production. It's not an easy task, but Dowell engineers are doing it every day.

Dowell is the only service company with twenty-six years experience in oil well stimulation work. And Dowell has the wide assortment of chemicals, additives, and temporary plugging agents required to tailor treatments for practically any formation.

Have any marginal production? Let your Dowell engineer help you check your well records for additional production possibilities. This is a good time to take another look at your stripper wells. Dowell, Tulsa, Oklahoma.

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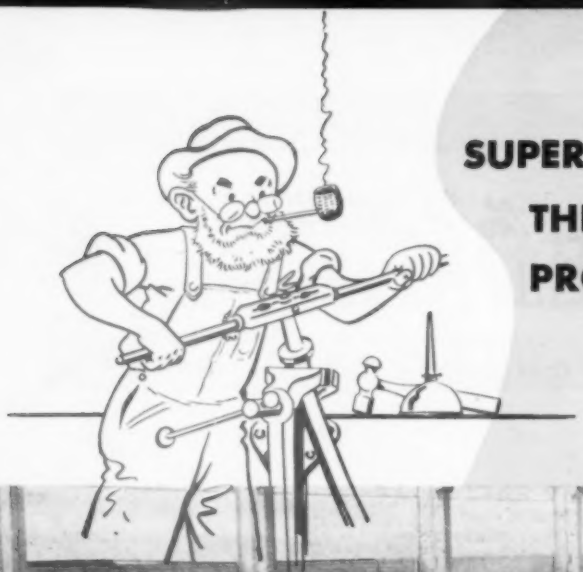
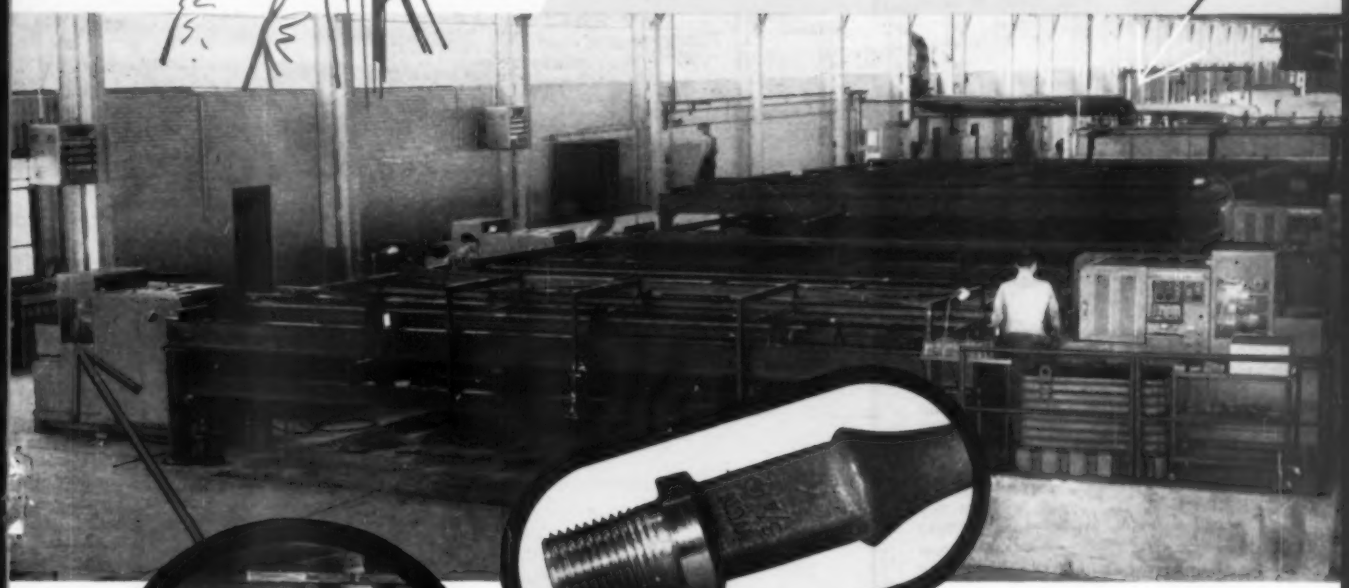
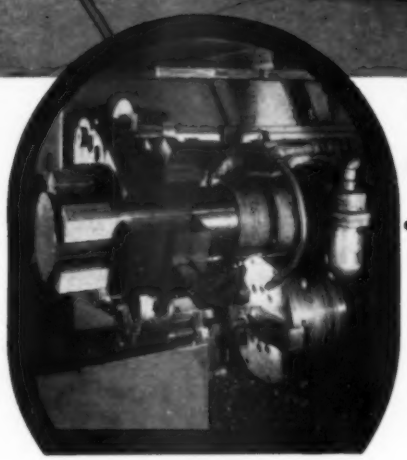


SUPER SENSITIVE *AUTOMATIC* THREADING* AND FINISHING PROVIDES UTMOST *UNIFORMITY*

**Grandpa could put a darn good thread on a buggy axle but it wouldn't pass inspection here.*



UNRETOUCHED FINISHED ROD END



Close-up of machine with automatic chucking-devices finishing rod end in four steps.

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A Magazine of Petroleum Management

the Petroleum Engineer

FOR MANAGEMENT

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Conceit is God's gift to little men. — *Bruce Barton*

The Real Threat of Soviet Science **A-23**

Danger from the USSR comes not so much from its competition with us as from the possibility we'll try to compete with its methods.

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Off on the Right Foot **E-3**

New employee may be scared, puzzled, confused — or brash, over-confident and careless — but in either case there are definite principles to help him get started right.

—*Eugene Whitmore*

How to Set Up a Five-Year Program **E-7**

Long range planning gives your management a much clearer idea of where your company is going, how you're going to get there and when. Here are some practical ideas to follow by one who has tried them. — *L. B. McKnight*

Authorship and Company Policy **E-11**

In the advance of science and engineering, publication is second only to discovery. Scientific experiments and engineering operations must be published before they can be duplicated or corroborated. This tells how 40 companies overcame literary lethargy. — *Scott Nicholson*

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the Petroleum Engineer
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The Case of the Disguised Depreciation

When you get right down to realism you find that profits are pretty watered and capital expenditures are as much inflation as modernization.

There's quite a howl about accelerated depreciation in Washington, D. C., where politicians are economists and economists believe in blue fairies. That wouldn't be so bad if they didn't keep us fooled, too. If we don't view our financial statements with a cynical eye we could get taken for a disappearing-profit ride.

Actually in the petroleum industry, funds get into the profit column that should be charged to depreciation, and money for capital expansion includes substantial sums to make up what a company should be able to supply with depreciation deductions.

You've probably read about the lathe that cost $12,000 in 1942 and required a million and a quarter dollars of sales for the company to replace. This works in the petroleum industry, too.

Standard of Indiana bought a $19,000 pipe bender in 1927 for its Whiting refinery. Today it costs $72,000 for a modern tool to replace it. To earn enough net profit to replace the bender, Standard has to sell $975,000 worth of products, not counting gasoline taxes.

The Magnolia Oil Company's controller department worked out this problem as another example: An average oil company built a new 80,000-bbl tank in 1928 at a cost of $23,000. When the tank had to be replaced in 1957, the $23,000 set aside for that purpose wasn't nearly enough. Inflation and improvements put the tank at $110,000 — an increase of $87,000.

The average oil company had an average margin of 9.7 cents profit on a dollar of sales, so to get the extra $87,000 for the tank it had to use all the profit it earned on nearly $900,000 worth of sales. That would be 7 million gallons of gasoline.

Give those figures on depreciation and profits and capital expenditures another look. If we don't get some realism into our accounting, we'll go broke, before we even realize that our profits are invisible behind that flimsy facade.

Either the write-off period should be freely chosen by the company or replacement should be substituted for original cost as a basis for amortization. Otherwise depreciation means little for all practical purposes. Your replacements look like expansion and your depreciation looks like profits.

It's your government — do you think you could get the idea of sound depreciation practice over to your congressman and senators? Let's quit fooling ourselves.

Ernestine Adams

Congrats and $25 to R. W. WARING, 511 Oil & Gas Bldg., Oklahoma City.

Oil and gas . . so vital to the world's economy . . is destined for an upturn in demand in coming months, according to the nation's leading oil men.

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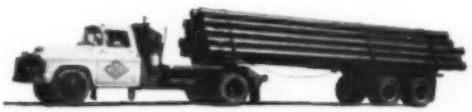

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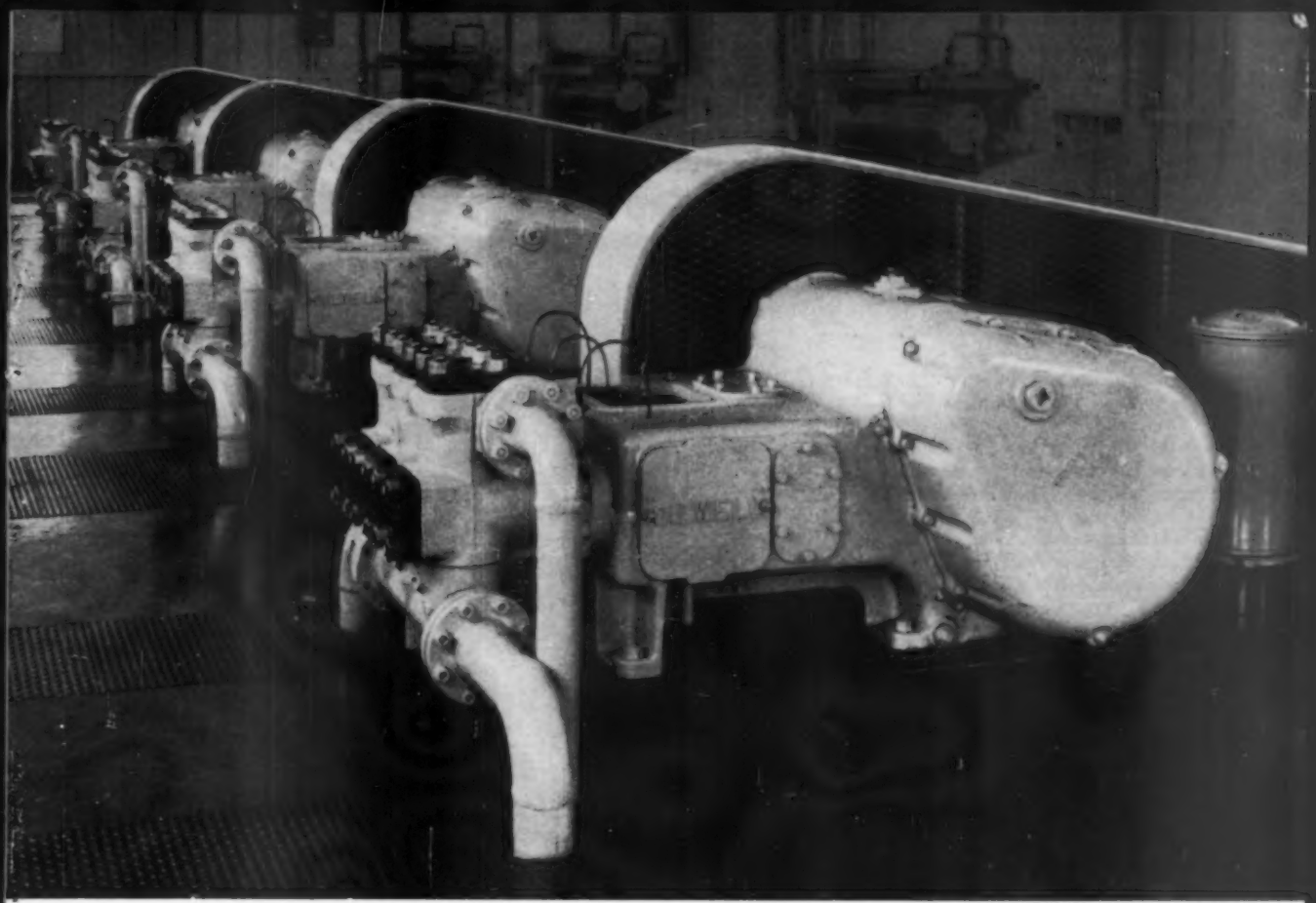

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TRADEMARK

Petroleum Profile

"WE'D be in the same economic situation if we weren't importing a drop of oil," said the man.

The interviewer stopped, asked for a repeat and got it . . .

Raymond L. Tollett can always be depended upon for a fresh approach. He goes past all the tired ideas and worn cliches, and heads for untrampled ground. He did give some orthodox reasons for his statement.

"Producers would be selling more oil but at a lower price."

He explained this by saying posted field prices would probably be down 25 to 50 cents a barrel if major company buyers were not saving on raw material costs through importing either their own or purchased foreign crude. "The industry," he maintained, "is not exempt from fluctuations in the general economy."

His second reason was: "Excess refining capacity was built up deliberately and with government support." Then: "Natural gas took a big part of the heavy oils market."

He added: "When you have as large a demand for crude oil as this country does, a two percent change can cause trouble. It's not oversupply, anyway, it's abundant supply."

This tells you one thing about the president of Cosden Petroleum Corporation, Big Spring, Texas. He isn't run-of-the-mill.

When he was only two, his father, an oilfield worker, moved the family from Cotton County, Oklahoma, to the early boom field of Burkburnett. Ray grew up in North Texas oilfields, his family eventually settling in Wichita Falls. From the time he was 11 years old, he worked outside of school. First he was a newsboy; at 12 he got a job at Western Union as a messenger, and by the time he was 15, he was driving a team and later a truck in the oilfields.

Combine abundant energy with Ray Tollett's incisive mind and you have a part time roustabout graduating from Wichita Falls high school as president and valedictorian of his class in 1925. When he won a scholarship to Cline's Commercial College, he went to school in the morning, worked in a clothing store in the afternoon and in a theater in the evening.

His first office job was with Panhandle Refining Company. Less than two years later, he was head bookkeeper of the (Clint) Murchison Oil Company, reading law and taking an extension course in accounting.

At the age of 24, he had been admitted to the Texas State bar and a year later licensed as a Certified Public Accountant. Working for Fain-McGaha at the time (Murchison had moved to Dallas) he opened an office for spare time practice with his employers' blessing. Unexpectedly he got into his next job.

RAYMOND L. TOLLETT,

President

Cosden Petroleum Corporation

A client wanted to join the Federal Bureau of Investigation and Tollett completed the examination to learn the ropes. He was offered a job and accepted. Two and a half years of intensive work and wide travel with the FBI was ended in 1939 when Tollett left to become secretary-treasurer of Wrightsman Oil Company and two years thereafter joined Cosden Petroleum Corporation in the same post. The Cosden firm had gone through bankruptcy and it needed someone like dynamic young Tollett to pull it back to its feet. In 1940, he first became executive vice president and then president later that year.

He closed the elaborate offices in Fort Worth and moved everything to the Big Spring refinery. Not until 1956 did he move the general offices to a new Cosden building in town.

Cosden's exceptional growth has been one reward of Ray Tollett and his staff. When he went with the company, shareholders' equity was $3 million; in 1957 it was $33 million. In his first year as president, the company lost $50,000 and paid no dividends; in 1957, it made $6 million and paid out $2¼ million in dividends.

"A professional manager," is the title Mr. Tollett gives himself. The company has widespread ownership, and Tollett has the third largest single interest, which is less than 2 percent.

"I've got plenty of bosses," he laughs, "seven directors, 8000 stockholders, 900 employees, the bank . . ."

Asked if he were going into foreign operations, he said, "We need more money than we can generate to expand our plant and production right here."

A daughter by Tollett's first marriage and her three children live in Tucson, Arizona. He has two sons and a daughter by his second marriage.

There'd be no space for anything else if we listed all of Mr. Tollett's affiliations. He not only keeps up with his community, and petroleum industry organizations, he belongs to accounting associations, to Former FBI Agents, is director of two banks, etc. He needs to be a dynamo to get around to all his work and activities.

LONGER, MORE PROFITABLE ROLLER LIFE—THE RESULT OF CONTINUOUS IMPROVEMENT OF CATERPILLAR PARTS

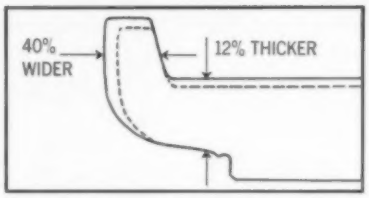
Cat "500" Track Rollers for D8s now have increased rim size for greater strength

A ceaseless search for ways to improve parts performance goes on at Caterpillar. Engineers are constantly striving to make each machine part do its job better, longer and more economically. The payoff for the customer is the steadily improving performance of Cat machines on the job.

New "500" Track Rollers for Cat D8 Tractors, for example, have been redesigned to better resist wear and breakage on the tough jobs. The roller rim has been thickened 12% in its critical area; the flange is 40% wider. The new design prevents roll-over and bending of the outer flange under severe side hill loads.

All Cat roller rims are designed so that treads and flanges may be economically rebuilt by automatic welding—a feature which results in big savings over the life of a tractor.

But that's only part of the story. Matchless Caterpillar quality starts with selection of steel. Extensive testing in Caterpillar metallurgical laboratories eliminates all but the finest quality steel *before* roller manufacturing begins. Further tests (61 in all) are made at every stage of production.



ADDITIONAL MATERIAL on new D8 roller rim is shown by dotted line, above. Thicker, stronger flanges give greater wear resistance and a longer productive life.

Cat roller rims are made from forgings to insure maximum strength and uniformity. They are bored and given a controlled heat treatment producing thick, file-hard wear surfaces; the remainder is left tough to resist shock damage.

These rims are shrunk onto cast-iron hubs of high compressive strength and then center welded. This prevents bore distortion and separation. Automatic precision machines finish-bore the roller assemblies. Careful inspection guarantees uniform quality.

Similar Caterpillar quality is built into track roller bearings and shafts, too. A special bronze alloy is used in Cat bearings to support extra-heavy loads. A cast-iron bushing with high compressive strength encloses the bearing.

There is only one way to get maximum production—the production you paid for—from your equipment. Keep your big, yellow machines on the job by using only constantly improved genuine Cat parts. Your Caterpillar Dealer has full information about the new Cat "500" Track Rollers and all the other quality Caterpillar parts. See him today.

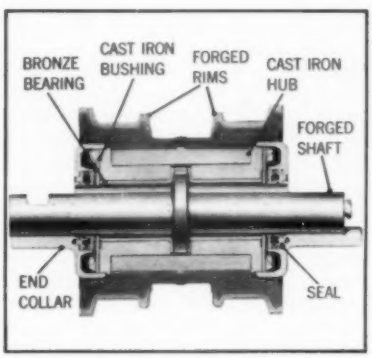
Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

SERVICE TIP

Ask your Caterpillar Dealer about the additional economies provided by 500-hour lubrication periods.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.



ROLLER CROSS SECTION of Cat "500" Track Roller shows rugged construction. Roller shafts are forged for controlled grain structure, maximum toughness and to permit superior heat treatment. Wear surfaces are hardened to a depth of at least 3/32", leaving a tough, strong core.

TOUGH JOBS, like the one pictured above, play havoc with any but the best track rollers. Here's what happened on an actual job: New Cat rollers were installed on the right side of a tractor; another brand of rollers on the left side. After 668 work hours, seals and bearings of two of the other brand rollers failed. They broke up and were lost from the roller shell. The Cat rollers showed normal wear and the 500-hour lubrication proved its value. Owners everywhere are proving that it pays to standardize on Caterpillar—equipment *and* parts.

THE CONFERENCE TABLE

Conceit is God's gift to little men . . . . . BRUCE BARTON

They Tell Stockholders

Some of the most interesting reading about the oil industry is found in annual reports and in reports of company officers to stockholders at annual meetings and when dividends are sent out. We have chosen three highlights that were in pamphlets sent to stockholders recently.

From Socony Mobil Oil Company:

"We Help Meet Growing Gas Demand. Natural gas is competitive with some petroleum products, to a greater degree than most people realize. The outlook for natural gas demand is of considerable interest to us. Our company's estimated domestic natural gas reserves are more than 10 trillion cubic feet and last year we produced one billion cubic feet a day.

"Since 1946, natural gas consumption in the United States has more than doubled. We expect that by 1967 it will be about half again as large as last year. By then it will be supplying 27 percent of this nation's energy compared with 13 percent in 1946. Petroleum, by comparison, will be supplying 43 percent."

From The Texas Company:

"Double Taxation on Dividends. Congress may take some action to reduce tax rates or to make reforms in the overall tax structure. Therefore, it may be timely to bring to the attention of our lawmakers the desirability of eliminating double taxation on dividends.

"With the corporate tax rate of 52 percent and the average individual taxpayer paying taxes of at least one-third of his gross income, not more than 32 cents out of each dollar earned by a corporation can stay with its stockholders, even if the corporation pays out every cent it earns. This means that, even if no funds are reinvested for expansion, a corporation must earn about $3.13, before taxes, for each dollar of "take home pay" for its stockholders. Such a confiscatory tax structure is detrimental to the national economy and must be modified if our country is to continue to have steady capital expansion and increased producivity and employment."

From Continental Oil Company:

"Anti-Trust Charge. You have probably read in the newspapers about the indictment on May 29 of 29 oil companies, including Continental Oil Company, by a federal grand jury at Alexandria, Virginia, charging violation of the anti-trust laws. No individual defendant was named.

"The wholly unfounded indictment specifically charged these companies with conspiracy to fix prices of gasoline and crude oil.

"It must be remembered that the indictment is simply a statement of charges, which we know is incorrect. We stand ready to present our case and are certain that the complete innocence of Continental Oil Company will be established in the American courts.

"As a customer for petroleum products, you are certainly aware of the fact that there is seldom if ever complete uniformity of prices for gasoline. There are various standards of quality and price. At those stations where prices are fairly uniform you can be sure that this is the best evidence of competition at work.

"Under normal marketing conditions — where a 'price war' is not underway — a single station operator would only raise the price of gasoline beyond that of his competitors at the risk of losing much of his business. Neither can he undersell his competitors very much unless there is a genuine economic justification for the decrease. He might gain some business for a few hours, but the same economic justification will permit his competitors also to lower the price.

"Competition, and competition alone, sets the price of gasoline.

"The price of gasoline today, as compared with other cost-of-living items, is truly a bargain. A major contribution to the increase of gasoline prices during the past 33 years has been the advance in gasoline taxes, a factor not known or made understandable to the public at large. Since 1925, these taxes — including federal, state and local — have increased more than 320 percent. Figures compiled by the United States Consumer Price Index show how little gasoline prices have increased since 1925, as follows:

Gasoline (without taxes)	7.4%
Gasoline (including taxes)	37.2%
Clothing	66.9%
Meats, poultry and fish	138.8%
Cereals and bakery products	89.3%
All food items	83.6%
All items	64.4%

"We welcome the opportunity this indictment affords, because it is our firm conviction that it results from a grave lack of understanding of the forces of economics and competition in the oil industry. By explaining our complex operations in detail before a court of law, where the rules of evidence will permit an impartial and unbiased examination of the facts, we are confident that Continental Oil Company will be completely vindicated."

Hallanan Awarded Degree

Walter S. Hallanan, Plymouth Oil Company president, was presented the honorary degree of Doctor of Laws by Waynesburg College at its one hundred seventh commencement this spring.

In extending recognition to leaders of basic American industries, the college board selected Mr. Hallanan as the man most representative of the oil business. Others similarly honored at the exercises included Benjamin Fairless, president of the American Iron and Steel Institute; William P. Snyder, president of Crucible Steel Company, and Mark W. Cresap, president of Westinghouse. The degrees were conferred by Dr. Paul R. Stewart, president of Waynesburg College.

Dr. Stewart reported that after canvassing the leadership of the petroleum industry, the college's board of trustees decided that Mr. Hallanan, as president of Plymouth Oil Company, one of the largest and most successful independent oil companies, and as chairman of the National Petroleum Council, best typified "the character of forward-looking leadership that has caused the petroleum business to be recognized as indispensable to the national welfare and security."

(On July 6, Mr. Hallanan suffered a heart attack. He is reported to be recovering satisfactorily.)

Promising Foreign Areas

Since we began our Foreign Areas of Promise with Venezuela last November, we have received a number of letters showing interest in the series. You may be interested in some of these comments.

☆ ☆ ☆

"I sincerely want to congratulate you and your staff for such excellent contribution to the knowledge of the oil picture of Venezuela. I will keep said issue as a source of current information on Venezuela."

Carlos Perez de la Cova, Minister of Mines & Hydrocarbons, Caracas, Venezuela.

☆ ☆ ☆

"The Petroleum Engineer *dedicated to Venezuela contains a wealth of information about the industry, and as far as we can see, all very accurate. You deserve sincere congratulations."*

F. J. Lara, Director, Embassy of Venezuela, Washington, D. C.

☆ ☆ ☆

"I want to congratulate you on your current issue of your publication featuring Venezuela. I thought I was familiar with developments in that country, but your articles show I am twenty years behind.

"As is always the case of your work, the subject is beautifully and expertly handled."

Roy M. Johnson, Ardmore, Oklahoma.

☆ ☆ ☆

"The Peru Number just arrived and it is excellent. You have done a splendid job in boosting the prospects of these countries — specially the latter two — Colombia and Peru."

E. Ospina-Racines, Consulting Engineer, Bogota, Colombia.

☆ ☆ ☆

"Our copy of the April issue of the 'PE' arrived several days ago and I have had an opportunity to read it. You certainly are to be congratulated! I would say that it was the work of genius to dig up such a number of good articles on the subject."

Douglas Fyfe, Compania Peruana De Petroleo "El Oriente" S. A., Lima, Peru.

☆ ☆ ☆

"I must write to congratulate you on the excellent number on Colombia produced by The Petroleum Engineer. *You seem to have managed to produce a very interesting selection of articles touching on a wide variety of subjects. I did not think that it suffered anything in comparison with the number on Venezuela."*

R. H. T. Hingston, Shell Condor, S. A., Bogota, Colombia.

☆ ☆ ☆

"The April issue is really very well done and gives very interesting information on Peru."

J. E. Rassmuss, Consulting Geologist, Lima, Peru.

☆ ☆ ☆

"I enjoyed indeed reading your April number of The Petroleum Engineer. *Dedicated to Peru, this number has articles on the geology of that country and its problems which are excellent. You could not have found better authorities for your material than Dr. Ruegg, Dr. Rassmuss, and others of equal knowledge and experience in their fields.*

"I should mention that your February number, dedicated to Colombia, was as excellent and enlightening as this last one. You present a wealth of up-to-date information, reports and statistics all of which are invaluable to anyone following the petroleum development of the potential of these South American lands.

"Having spent many years exploring the geology and geologic structures of South America, I happen to be very familiar with the countries and some of the authors of your articles. Accept my congratulations for an excellent job of editing and presentation of valuable and interesting material."

Victor Oppenheim, Oppenheim and Briscoe, Dallas, Texas.

☆ ☆ ☆

"I should like to thank you for the fine article on Colombia which recently appeared in your publication. It was of considerable interest to us."

R. F. Alexander, Geophysical Services, Inc.

☆ ☆ ☆

"You are to be congratulated on such a fine presentation of petroleum operations."

Victor Andrad, Ambassador of Bolivia.

Sales Up

Business for 1958 is sky-rocketing at OTM Corporation, Houston manufacturers of flanges and fittings. Number of orders booked for the first four months of 1958, in comparison to the first four months of 1957, is up 25 percent.

To keep up with the tremendous percentage-hike in orders, production at OTM Corporation has also been on the up-grade. Over 5 percent more material has been manufactured at OTM's plant during 1958 than was produced in the corresponding four-month period of 1957.

"Our business is good and it is getting better, and we of the OTM Corporation intend to see it improve even more," said Kenneth H. Bradshaw, vice president and general manager of OTM Corporation. "We put on two shifts in the shipping department during the month of April, this being done for the first time in the history of the business."

Another oil supply company, Merla Tool Corporation, Dallas, Texas, has just completed the most successful fiscal year of business in its 24-year history. The firm has had a steady year by year business increase.

Officers believe that with constructive instead of destructive thoughts in business discussions, the cycle of "depression" can be slowed down, stopped, and motion reversed.

Because they are demonstrating a company can buck the trend, we congratulate these two companies.

Look It in the Face

What the public thinks about us isn't often something to shout about but we'd better face the facts.

To find out the public opinion of its own company, Standard of California regularly enlists the services of a polling organization. After presenting results in the May 1958 issue of *The Standard Oiler*, a series of articles is being published to refute some complaints of the public.

Here are some results:

1. 44% like the company; 43% are neutral, 13% dislike it.
2. 36% think the company is too big and powerful.
3. 20% think company is too large to best serve the public.
4. 39% think the company's prices are too high.
5. 43% think the company is a monopoly.

If your company hasn't had a similar poll, it is about time you did. We're never going to lick adverse public relations unless we know what we have to face.

HIGHLIGHTS

★ ★ ★

Digest of News and Comment

Sun Oil, Mathieson Plan Venture

Sun Oil Company and Olin Mathieson Chemical Corporation have announced plans to form a joint company to produce 73,000 tons of urea a year. Urea, a chemical used in chemicals manufacturing, fertilizers and cattle feed, is a derivative of ammonia, which Sun has been producing since 1956. The proposed urea plant would be at Sun's Marcus Hook, Pennsylvania, refinery.

NSPE Opposes Federal Scholarships

Large-scale undergraduate scholarships meted out by the government, as proposed in a compromise Federal aid to education bill, will be injurious to the nation's technological progress, protests the National Society of Professional Engineers. The society warned in a telegram to Congress that a massive Federal undergraduate scholarship program would only hinder the progress made by engineering educational institutions. While the emphasis on future training of scientists and engineers is commendable, such a plan would impose a serious burden on faculties and facilities of our colleges and universities and delay progress by placing stress on quantity rather than quality.

4½ % Pipeline Tax Erased

President Eisenhower has signed the Tax Rate Extension Act of 1958 which, in part, removes the 4½ percent tax on transportation of oil by pipeline effective August 1. Since there is no tax on gas transportation, the elimination of the tax is expected to improve the competitive position of oil as related to gas. It is also predicted that oil pipelining will reap certain advantages over trucking and barge carriers. The ICC assumes that the 4½ percent savings will be passed on to oil shippers.

BofM Looks at Shale

Union Oil of California announced plans to close down operations at its three-year-old Grand Valley, Colorado, shale plant to permit analysis of technical information gained. Company officials indicated that the 750 bbl per day shale oil plant research had also produced operating data that was "quite a bit ahead of our economic analysis." They claim that a 25,000 bbl per day plant is feasible and could deliver to Pacific Coast markets semi-finished products at prices now posted for such crudes.

U. S. Bureau of Mines Director M. J. Ankeny indicated the plant's shutdown may lead to the reopening of B of M's own Rifle, Colorado, plant. He stated that "we didn't want to operate the Rifle plant as long as private industry was in the same area . . . our position may be changed by this development."

British Columbia CPA Opened

A British Columbia division has been established by the Canadian Petroleum Association. CPA General Manager John W. Proctor stated that "extension of the association's services to the Pacific Coast province is a logical and necessary step as British Columbia's position as one of Canada's important natural gas and oil producing areas becomes more firmly established." T. W. G. Thomson, vice president and manager of Texaco Exploration Company has been elected chairman of the division's 10-man board of directors.

Pemex Asks Price Hike

Head of Petroleos Mexicanos, Antonio Bermudez, has asked for a 30 percent increase in prices of products in an attempt to solve the national oil monopoly's financing problems. Mexico has cut its imports from 57,000 bbl in May 1957 to 16,500 bbl in May 1958. The Pemex official expected the imports will end soon. Only problem yet unsolved is financial. Pemex now owes $55,200,000 and admits it will need financing for continued growth. Mexican economists are studying possibility of raising prices on gasoline and oil (one third U. S. price).

NLRB Rules Go Offshore

Jurisdiction of the National Labor Relations Board has been extended to employers operating on the continental shelf because of a new ruling involving Continental Oil Company. The board ruled its regulations are in force in this area by virtue of the Outer Continental Shelf Lands Act. A boat service, which had contracted its services to Conoco on offshore drilling rigs, contended the Act did not embrace commerce within an area under the jurisdiction and control of the U. S. In the decision, NLRB told the service to stop interfering with unionization activities of its employees.

West Coast Import Quotas Revamped

Importers of crude oil into the West Coast area have been asked to "move over" in order to make way for eight new companies in the voluntary control program. A reduction, averaging 6.3 percent, affects 16 companies. Actual cuts are not expected to run as high, since West Coast importers have been below allowed quotas in recent months. Total daily quota is 221,000 bbl per day. In the first five months of this year, importers brought in only 157,000 bbl per day.

Hancock Sale Talk Stops

Leaders of Hancock Oil Company of Los Angeles, California report that discussions regarding possible purchase by an un-named eastern oil company have been terminated. The company had previously announced that a sale was being considered. The talks began shortly after Hancock's Signal Hill refinery experienced an $8,000,000 fire.

Jersey to Buy Humble Stock

Standard Oil Company (New Jersey) has filed its intention to acquire the outstanding minority interest in Humble Oil & Refining Company. Jersey already owned 88.2 percent of Humble's stock. Announcement of the proposed stock exchange (five for four) on July 2 caused Humble stock to jump in price from 55 to 68, a gain of 13 points in the one day. Humble is the biggest oil producer in the U. S.

Iraq Oil at Pre-Suez Rate

Iraq Petroleum Company has succeeded in restoring the pre-Suez flow of oil to the Mediterranean. Managing Director G. H. Herridge states that oil from Northern Iraq is again flowing to Mediterranean terminals at a rate of 25 million tons per annum. Flow was cut off in November 1956 by the destruction of pumping stations in Syria.

Cities Service Outlets to Cosden

Retail marketing outlets belonging to Cities Service Oil Company in the Dallas-Fort Worth, West Texas and eastern New Mexico area have been acquired by Cosden Petroleum Corporation, Big Spring, Texas. The transaction includes purchase of both bulk outlets and service stations. R. M. Johnson, vice president of sales for Cosden, estimated the acquisition would increase its branded distribution by 30 percent.

ROPE TRICK

Most amazing are the myriad tricks performed by modern wire rope.

It lifts you from street level to skyscraper heights in seconds . . . hoists stone from quarries . . . helps build the highways, supports the giant suspension bridges over which you drive.

But this giant could not serve you until its muscles were made more flexible . . . protected against friction, rain, mud, even underwater service. Petroleum research solved these problems with a unique lubricant.

This kind of research, in which Texaco is a leader, provides benefits in swiftly built highways, great dams, tall buildings, giant bridges . . . progress on many fronts *to serve you.*

TEXACO

Progress . . . at your service

THE TEXAS COMPANY

HIGHLIGHTS—2 Digest of News and Comments

Tankwagon Prices Up

Higher and firmer wholesale prices for gasoline were noted in most sections of the country in late July. In eastern U. S., Esso Standard initiated a boost at the tankwagon level in its 10 state marketing area. Gulf Oil followed in New York, New Jersey, and Connecticut with 0.2 to 2.0 cent increases. Standard of Indiana led off higher prices in the Midwest by hiking the market in seven states. On the West Coast, first increases were made in the Los Angeles area on the July 4 weekend. All West Coast prices are reported firming up at the retail level because of lower inventories.

Albertans Reap Oil Payments

While most Americans face more taxes, citizens of Alberta, Canada, will be receiving $17.50 a week for the rest of the year as their share of oil royalties received from oil production in the province. Royalties from producers during the current fiscal year ending March 31 will hit $30,000,000. Two-thirds of this amount will go into the treasury and the rest will be distributed to Albertans. On the other hand, Alberta levies 10 cents a gallon retail gasoline tax and an amusement tax.

Iran, Mexico Look for Money

An open invitation to U. S. oil companies to aid in the economic rehabilitation of Iran has been issued by Shah Mohammed Reza Pahlavi. The young ruler called on American private capital because of its "bold, imaginative measures." The Shah pointed out new and more favorable laws now existing in his country for oil opportunities. Two important agreements have recently been signed, one with AGIP, an Italian company, and with Standard of Indiana.

In Mexico, national leaders are again advocating the implementation of foreign capital to give Pemex, the national oil company, enough funds for future growth. Business groups within the country, however, have been opposing the suggestion that U. S. capital be asked. In an attempt to help its own situation, Pemex has almost doubled prices on most of its petroleum products.

States Increase Flow

August permissible oil production in major producing Southwestern states was raised substantially for the first time in several months. Texas Railroad Commission authorized prorated wells to operate 11 days — two more than in July. This lifted allowables to 2,977,211 bbl per day for August. This is the highest flow since January but still a million barrels less than in the Suez crisis. All witnesses at the RRC hearing July 17 favored sharp increases — one refiner asking for a 14-day flow.

In New Mexico, Oil Conservation Commission raised August allowable in the southeastern part of the state to 35 bbl per day per well — two higher than in July. In the Northwest wells will be allowed 51 bbl per day during August.

Louisiana's Conservation Commission set the monthly allowance at 815,000 bbl per day, an increase of 55,000 bbl per day over the previous month's permissive flow in prorated fields.

Voluntary Program Upheld

A bench opinion by a federal judge in Washington, D. C., has upheld the voluntary oil imports program and denied a motion by Eastern States Petroleum & Chemical Corporation for an injunction against use of the Buy American Act to suspend its military fuel contracts because of the company's non-compliance with the program. Attorneys for Eastern States indicated that an appeal would be made. The judge dismissed the company's suit "on its merits."

Indonesia Asks Shell's Return

Government of Indonesia has invited Shell Oil Company to resume its operations in East Borneo, assuring that there is no longer any threat of rebel attack. Shell closed its 50,000 bbl per day refinery and evacuated employees' families from East Borneo because of rebel air attacks in the area. The government is reported to be "cleaning up" rebel action and is assuring a complete and early loyalist victory.

Conquest for Oil?

Oil industry public relations shows its raggedy condition in the Mideast crisis. For instance, a Socony stockholder — a teacher at Smith College — wrote President Nickerson saying he'd rather never get another cent from Socony than to have the government intervene to protect American oil interests. Socony's president, of course, agreed.

If there had been oil in Korea, a lot of people would have blamed that for the war there. The Mideast crisis is on the intangible side — best guess is that we'd been pushed around until we ran out of cheeks to turn.

Meetings

Aug. 14—API OIC Steering Committee, Waldorf-Astoria Hotel, New York City.
Aug. 18-20—ASME, Heat Transfer-AIChE Conf., Edgewater Beach Hotel, Chicago, Ill.
Aug. 25-27—Appalachian Gas Measurement Short Course, University of West Virginia, Morgantown, W. Va.
Sept. 3-5—API Oil Information Committee, Hotel Statler, Boston, Mass.
Sept. 4-5—AIME, second international congress on air pollution, Statler Hotel, New York City.
Sept. 7-12—American Chemical Society, fall meeting, Chicago, Ill.
Sept. 9-12—10th National Chemical Exposition, Chicago section of the Amelcan Chemical Society, International Amphitheatre, Chicago, Ill.
Sept. 10-12—Mid-Continent Oil & Gas Assn., Mississippi-Alabama annual, Buena Vista Hotel, Biloxi, Miss.
Sept. 10-12—National Petroleum Association, 56th annual meeting, Traymore Hotel, Atlantic City, N. J.
Sept. 14-16—INGAA, annual membership meeting, Roosevelt Hotel, New Orleans, La.
Sept. 15-17—Electrical Conference of the Petroleum Industry sponsored by AIEE, Baker Hotel, Dallas, Tex.
Sept. 15-19—13th Annual Instrument-Automation Conf. & Exhibit, Philadelphia, Pa.
Sept. 18—NGAA, Rocky Mountain regional, Gladstone Hotel, Casper, Wyo.
Sept. 18-20—Rocky Mountain Assn. of Geologists, symposium of Pennsylvanian rocks, field trip to Paradox Basin, northwest and eastern Colorado.
Sept. 21-24—ASME, Petroleum Mechanical Engineering Conf., Cosmopolitan Hotel, Denver, Colo.
Sept. 21-24—American Institute of Chemical Engineers, regional meeting, Hotel Utah, Salt Lake City, U.
Sept. 22-28—ASTM, Statler Hotel, Boston, Mass.
Sept. 24-25—WPRA, Rocky Mountain regional technical-industrial relations meet, Henning Hotel, Casper, Wyo.
Sept. 25-26—Mid-Continent Oil & Gas Assn., Arkansas and Louisiana annual, Roosevelt Hotel, New Orleans, La.
Sept. 25-27—Illinois State Geological Survey's biennial Petroleum Engineering Conf., University of Illinois.
Oct. 1-2—WPRA, 3rd Annual Stream Pollution and Waste Disposal Conf., Lassen Hotel, Wichita, Kans.
Oct. 1-3—AAODC, 18th annual, Adolphus and Baker hotels, Dallas, Tex.
Oct. 3—AIChE, South Texas Section, 13th annual technical meeting, Moody Center, Galveston, Tex.
Oct. 5-8—Society of Petroleum Engineers of AIME, fall meeting, Houston, Tex.
Oct. 6-8—NACE, northeast region meeting, Boston, Mass.
Oct. 7-8—Texas Mid-Continent Oil & Gas Assn., 39th annual, Statler Hilton Hotel, Dallas, Tex.
Oct. 9-10—ASME-AIME, conference on fuels, Chamberlain Hotel, Old Point Comfort, Va.
Oct. 9-10—California Natural Gasoline Association, 33rd annual fall meeting, Huntington-Sheraton Hotel, Pasadena, Calif.
Oct. 12-18—OIL PROGRESS WEEK.
Oct. 13-15—AGA, 40th Annual Conf., Traymore Hotel, Atlantic City, N. J.
Oct. 13-15—ASME-ASLE, conference on lubrication, Statler Hotel, Los Angeles, Cal.
Oct. 13-16—Society of Exploration Geophysicists, annual meeting, Gunter Hotel, San Antonio, Tex.
Oct. 16-17—AIME, Southern California Petroleum Section, fall meeting, Biltmore Hotel, Los Angeles, Calif.
Oct. 16-19—Permain Basin Oil Show, Odessa, Tex.

Good Wells Make Good News

A Monthly Report of Successful Well Treatments

August 1958

In many formations, fracturing gives better results than other stimulation treatments. Production increases are excellent. Decline curves are improved. Ultimate recovery is often increased. Here are four examples of successful fracturing treatments by Dowell.

- **Converse County, Wyoming.** (Old oil well) This well in the South Glenrock pool was recompleted through perforations into the Muddy Sand. Dowell used Sandfrac* with 10,000 gallons lease crude and 15,000 pounds sand. Treatment was preceded with 54 ball sealers, a sufficient number to plug off old perforations. F.L.A.* (Fluid Loss Additive) was used to help extend the fractures, and Freflo* was used to assist clean-up. *Before treatment, well pumped 36 bopd. After treatment, well pumped 201 bopd.*

- **Montague County, North Texas.** (Old oil well) This well was completed in the Caddo lime from 6124 to 6188 feet. The producer ordered Duofrac* to get the benefits of a large high-injection-rate fracturing treatment with an acid-base fluid. Dowell injected 100,000 gallons three per cent acid and 50,000 pounds sand at 48 bpm. Average pressure was 2000 psi. Records show the treatment paid out in six months. Present production is 16 bopd. Most important, *decline rate was so flattened that an estimated 25,000 barrels of additional oil may be recovered.*

- **Grant County, Oklahoma.** (New oil well) This well was completed through perforations from 4258 to 4306 feet into the Cherokee formation. Before treatment, well tested only one boph. Dowell followed 500 gallons Mud Acid with Petrojel*, using 19,000 gallons gelled crude and 19,000 pounds sand in two stages. 44 ball sealers were used between stages. Injection rate averaged 23 bpm at 1850 psi. *After load oil was recovered, well tested 30 boph.*

- **Gibson County, Indiana.** (New oil well) Casing was perforated into two sections of the Aux Vases. The upper section was tight sandstone, 2766 to 2780 feet; the lower section was a comparatively permeable limestone, 2786 to 2795 feet. Dowell treated the limestone with 2000 gallons of the retarded-acid-action fluid used in Acid Petrofrac*. Then 20 ball sealers were injected, and the sandstone section was treated with Petrojel using 2000 gallons gelled crude and 2000 pounds sand. Before treatment, well tested only a show of oil. *After treatment, well tested 150 bopd, flowing.*

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Fig. 512 - Small Bronze Gate Valve for 150 pounds W.S.P. Inside screw non-rising stem. Solid wedge disc. Can also be supplied with flanged ends.

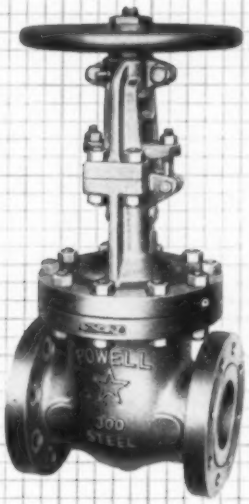

Fig. 3003 - Steel Gate Valve for 300 pounds W.S.P. Outside screw rising stem and yoke. Solid wedge Disc, screwed-in seat rings. These valves also available for 150 pounds and higher pressures.

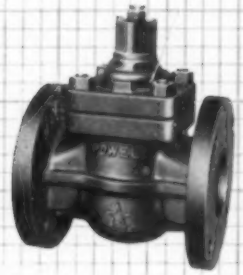

Fig. 2201 - Semi-steel Lubricated Plug Valve for 175 pounds W.O.G. Single gland type. Sizes 1" to 4". Can be supplied with screwed ends. Other types and higher pressure valves are available.

Fig. 1793 - Large Iron Body Bronze Mounted Gate Valve for 125 pounds W.S.P. Outside screw rising stem and yoke. Solid wedge disc.

Fig. 1561A - New Steel Swing Check Valve for 150 pounds W.S.P. When disc is in wide open position straight, unobstructed flow area through the valve is provided.

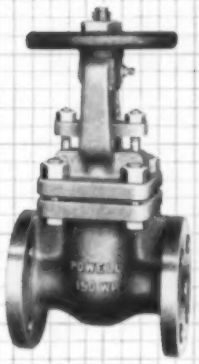

Fig. 2491 - Small Stainless Steel Gate Valve for 150 pounds W.P. Outside screw rising stem and yoke, solid wedge disc. Can be supplied with interchangeable double wedge discs. Available also with screwed ends.

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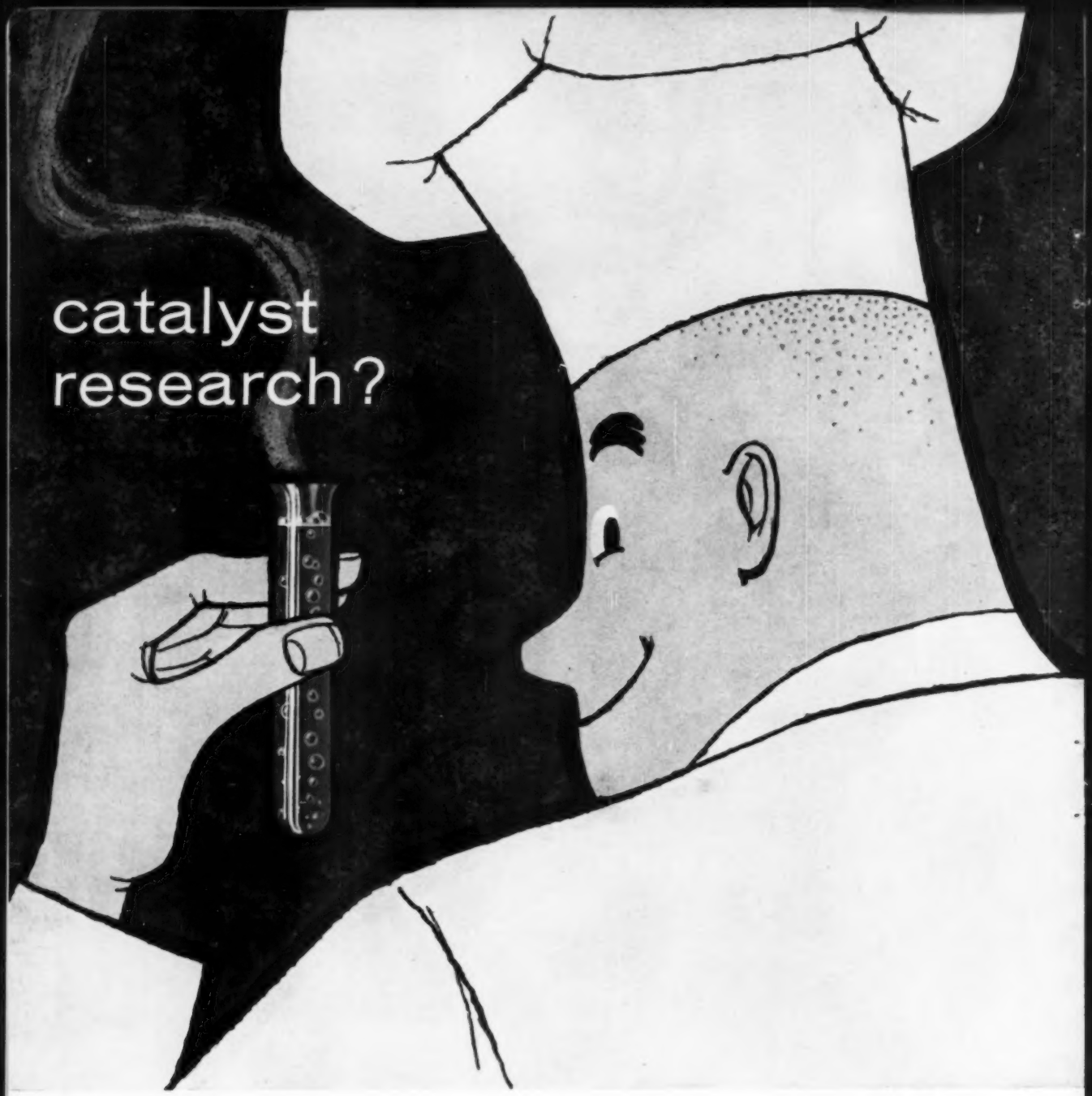

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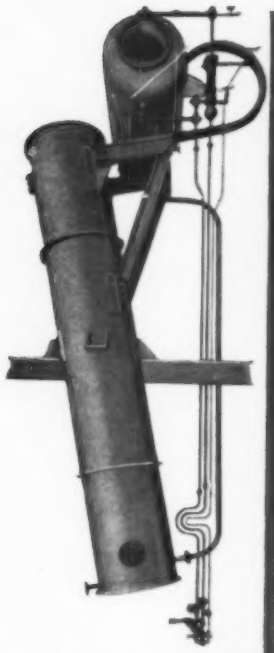
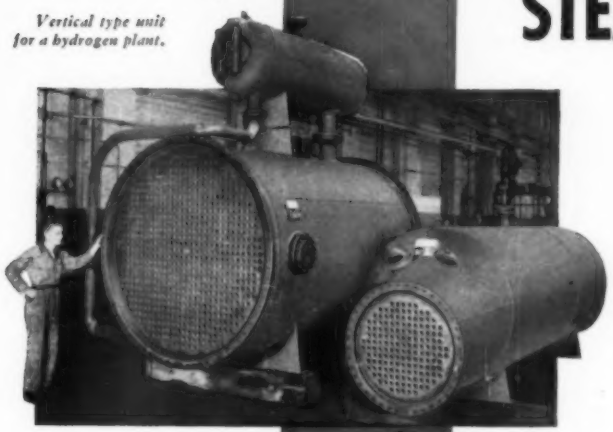
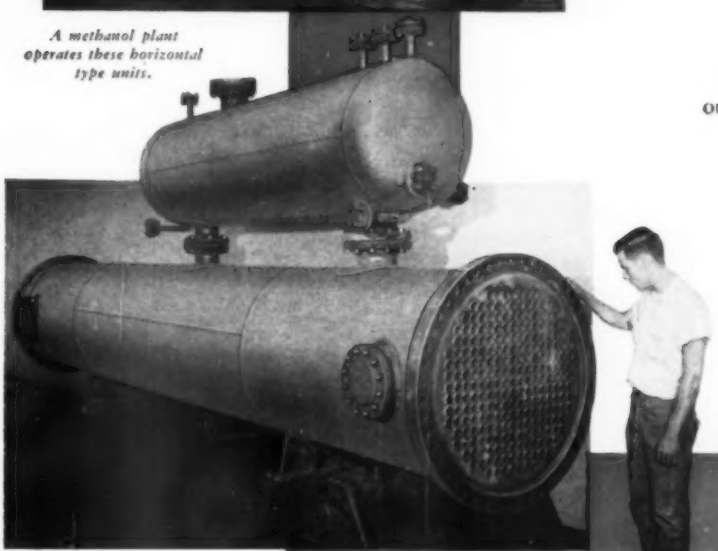


Vertical type unit for a hydrogen plant.



A methanol plant operates these horizontal type units.



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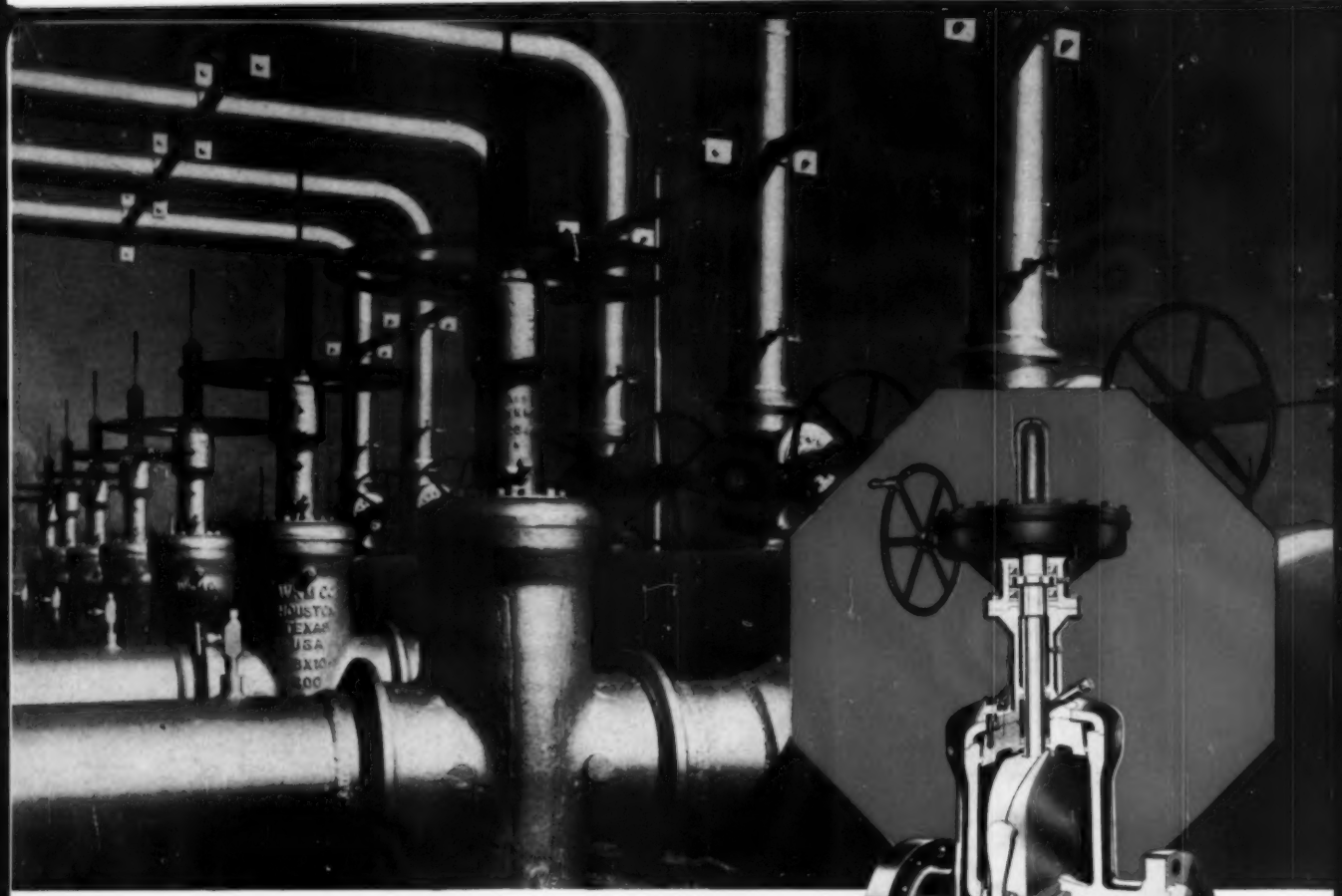

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The Real Threat of Soviet Science

NIKITA KHRUSHCHEV boasted the other day that Russia will show the world that Communism breeds a more productive economy than Capitalism.

"We'll see who eats better and who has more clothes," he said. "We'll catch up with the most advanced capitalist countries."

In light of recent Soviet achievements, few Americans will shrug off the Reds' economic challenge. Khrushchev well knows that if the Reds can out-produce the Free World they can dominate the globe without firing a shot.

That's a sobering realization. But it is not cause for panic. Every time the Reds send up a Sputnik or seem to move ahead of us on some other technological front, a few panicky people demand that the U. S. government compel American industry to bridge the gap.

And that is the *real* threat of Soviet science.

The Soviet method is compulsion. They have had far more experience with it than we have had. If we try to ape the Reds we will play right into their hands.

Our method is freedom. It is the heart of our economic system as well as the heart of our political and religious system. Freedom will win for us. But we need to guard it well. We need to have faith in it, to practice it, to fight for it.

Let's take a look at four of the basic elements of our free economic system.

Freedom to try anything

The essence of private property is your freedom to spend or invest your money in any legal way you please.

Spindletop, granddaddy of the modern oil well, was discovered by a man who persevered in the face of warnings by the U. S. Bureau of Mines and by prominent oil men that the area was unpromising.

Flight in a heavier-than-air machine was so clearly impossible that many ridiculed the idea even after the Wright brothers had made their first hop.

This freedom to innovate (or right to be crazy) has contributed many bright pages to the story of our industrial progress.

Freedom to compete

In this country every market (with certain exceptions, such as public utilities) is open to all comers. Competition brings wider choices and better values to the consumer.

Take the automobile tire. Small-minded men might have reasoned that to make better tires would curtail their market. Wiser heads have produced tires that last many times as long—and it has helped, rather than hurt, the sales and profits of the tire companies.

Freedom to make profits and losses

Profits are the accelerator on the economic automobile. When people want more of anything than is currently available, their demand steps on the profit accelerator and up goes production. When they tire of a product, as small boys tired of coonskin caps not long ago, profits drop or disappear—and that particular economic unit rolls to a stop.

The consumer does not *compel* us to produce the goods he wants; rather, he *persuades* us by his decisions to buy or not to buy.

There can be no compromise between persuasion and compulsion. Once we realize that, we can see the danger to our system when price ceilings are imposed in peacetime to deal with shortages. (If high prices have not persuaded enough people to produce enough goods to meet the demand, lower prices certainly cannot do so.)

Only when people understand this principle can they see that every reduction in incentive is a step toward compulsion, a loss of freedom.

Freedom to elect managers

When a businessman shows his ability to serve his fellowmen, they endorse him by buying from him. When that happens, his business—and his authority—becomes bigger. In a sense, it's a way of electing and promoting managers — another alternative to compulsion.

But no matter how great businessmen and businesses become, their wings are clipped if they forget that their profit comes from service to the public, that their authority depends on correctly anticipating the wants of free men.

THE DECADE just ahead promises to test our faith in freedom as it has never been tested before. Part of the test will come from the vast, almost incredible need for capital to maintain and increase the standard of living of our rapidly increasing population.

The Communists can create capital simply by paying the peasants less for their produce than it is worth. But in America saving is voluntary, and so is investing.

Limiting the profits of business—either through price controls or excessive taxation—would make it certain that the capital needed to meet the demands of our expanding population could *not* be obtained from private sources.

This is not a battle between capital and labor. It is a fight to preserve the best way of life man has yet found, and it comes at a stage in man's scientific development when we're fighting for keeps. If freedom is lost this time, it cannot be regained by embattled farmers armed with pitchforks.

We can preserve our freedom only if we understand it, have faith in it—and have the courage to fight for it.

From The Flying Red Horse, *Socony Mobil Oil Company magazine; Williard A. Colton, managing editor; issue of Spring-Summer, 1958.* ★ ★ ★

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2. Do more than touch . . . *feel!*
3. Do more than look . . . *observe!*
4. Do more than read . . . *absorb!*
5. Do more than hear . . . *listen!*
6. Do more than listen . . . *understand!*
7. Do more than think . . . *ponder!*
8. Do more than talk . . . *say something!*

— John Harsen Rhodes

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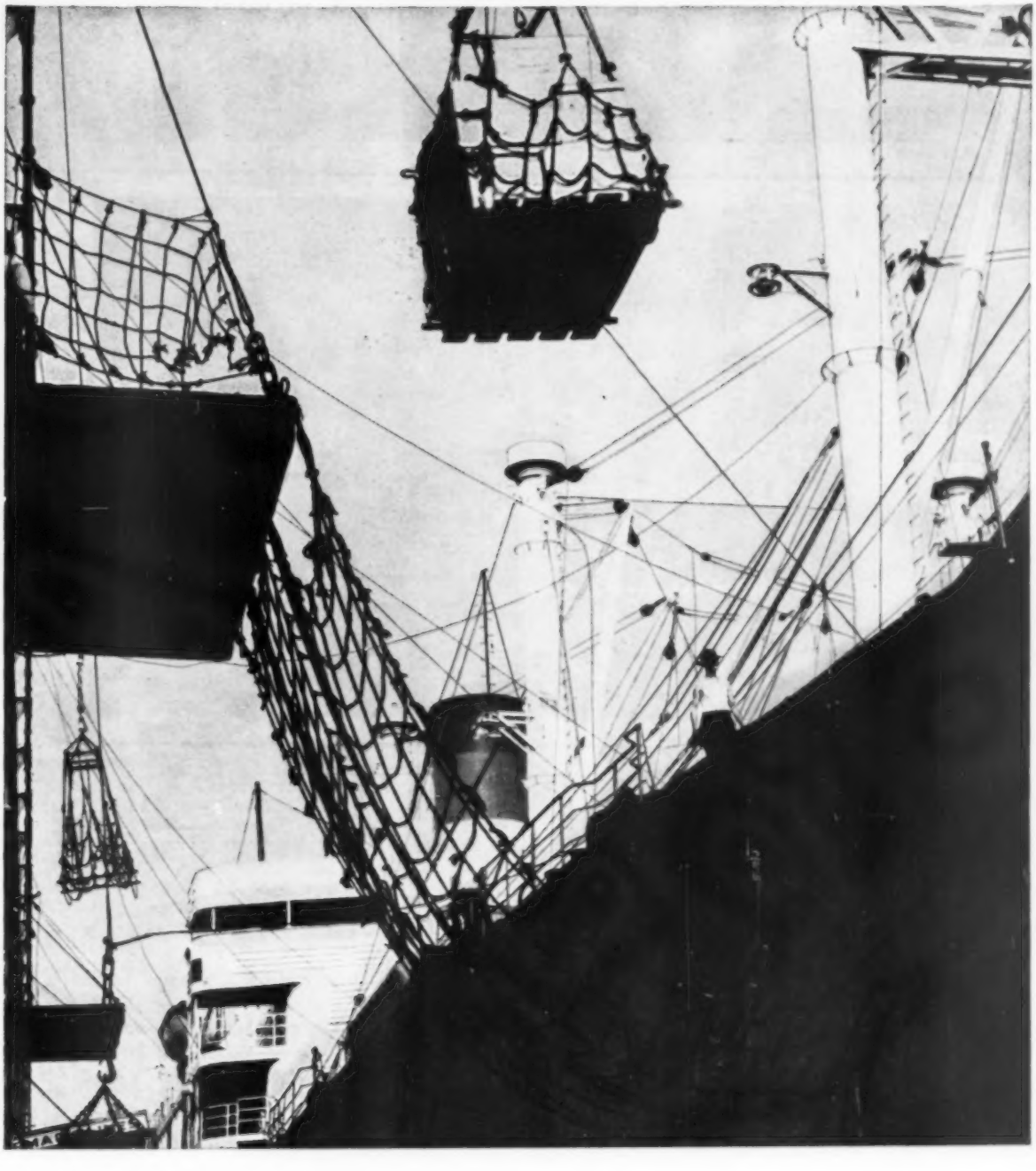

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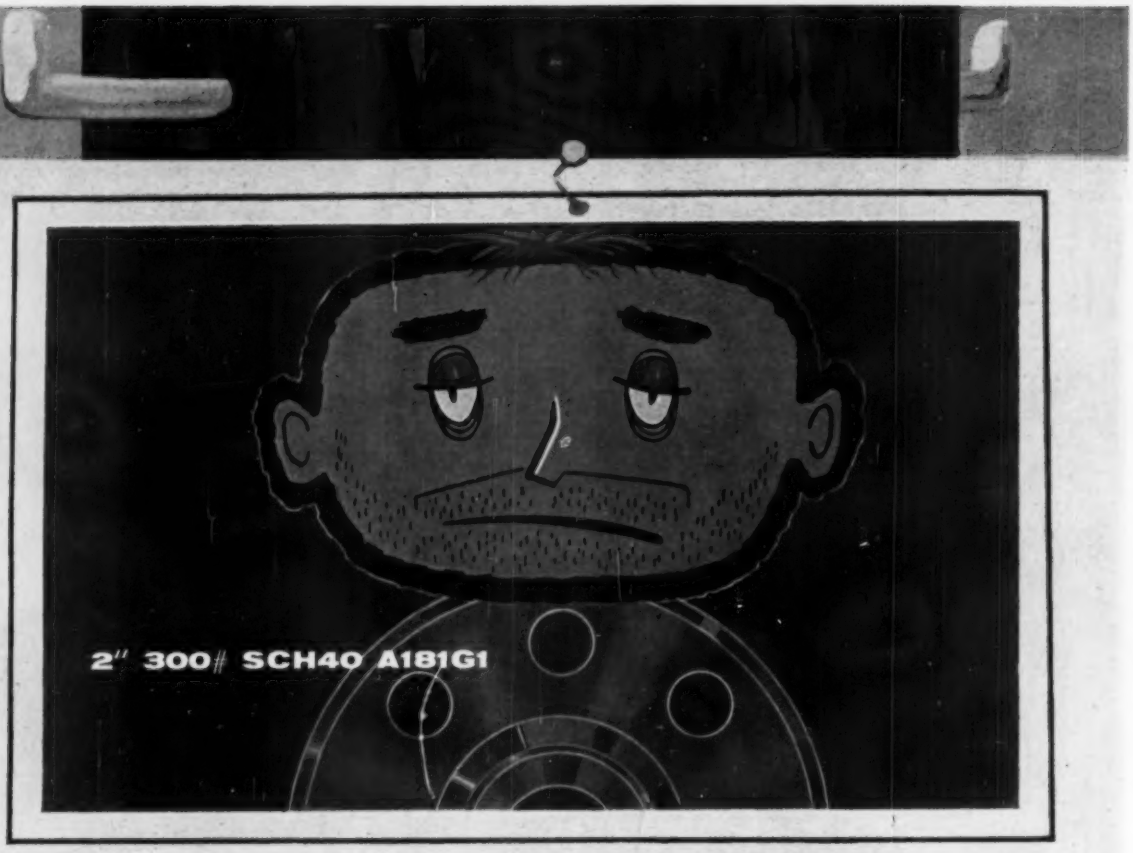

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OFF ON THE RIGHT FOOT

Eugene Whitmore

New employee may be scared, puzzled, confused—or brash, over-confident and careless—but in either case there are definite principles to help him get started right

FIRST DAY on the job for any new employee is trying and difficult.

If he is really promising material he may be more nervous and apprenhensive than the happy-go-lucky fellow to whom the new position is just another job.

The new man who is really ambitious and sincere may suffer much more than a less valuable employee. Many doubts and questions assail his mind as he reports to work on the first day. This is especially true when the new job represents some type of up-grading involving greater responsibilities than he has shouldered in previous work assignments.

It will pay any company to set up certain routines for helping the new employee to get his feet wet on the new job with the least possible friction, delay, and chance of misunderstanding. Here are some ideas which may be helpful.

Introduce him to fellow employees.

1. The Introduction

Let's assume that our new employee has been through the necessary formalities. He has been okayed by the medical officer; his Social Security records have been checked and recorded; employee record cards have been set up. Now he is told to report for a general assignment, perhaps to a department head or supervisor.

Many doubts and questions assail his mind. Who will be his immediate boss? Where is his (or her) work station? How will this job differ from the last job? Will he be able to handle the work? Will the old employees put him through a hazing period?

The supervisor "breaking in,"—the government calls it "indoctrinating"—a new employee should attempt to ascertain, first rattle out of the box, what the new employee has been doing in the past. He needs to find out more than may appear on the application blank, or any other papers which may have been passed on to the supervisor.

Have an informal chat first. Put the new employee at ease. Encourage him to talk about his previous work. Just what did he do? What tools did he use? How much experience has he in the exact type of work he will be expected to do on his new job?

Start with points of familiarity and build up from there. Show him how his new work is similar to his former task. And also show him how it may differ

Assign him to parking space.

Turn new employee over to an old-timer.

from what he has been doing on the old job.

Show him his work station, introduce him to fellow employees, take him to the tool crib, or supply department and introduced him there, telling the people in charge of these stations where he is working and giving them an estimate of his needs in the way of tools, supplies or equipment.

2. The First Assignment

One of the commonest errors in starting new people to work is to say, "I'm awfully busy this morning. You sit over there, and read this booklet, and I will see you later." Such a start puts the new employee in a state of mild terror or makes him ask himself, "What goes here? Don't they have work for me?"

Do not attempt to start the new employee on some temporary, easy job until you have a chance to talk with him. *Plan* your work so that you have time to give him an intelligent assignment, after the introduction, and put him to doing something useful at the earliest possible moment. And, do not expect him to be a mind reader and know just how to begin. Take the time to explain the assignment and, above all, explain the relationship of his work to others.

Try to give the new employee some idea of the importance of his work and from the very start help him acquire pride in his new job.

3. Find a Sponsor for New Men

One of the most successful plans used by many large companies is to turn the new employee over to an old-timer, known to have a good attitude and some skill at teaching. This sponsor should be relied upon to explain to the new employee that he will not be expected to "set the world on fire," the first day. He should also explain to the new employee the simple, everyday work rules in effect. The sponsor should point out safety rules, take him to lunch the first day or two, make him welcome in the department, inform him about smoking rules, requirements for safety clothing, helmets, gloves, or other requirements.

If the new employee is a skilled worker, master of some well defined trade or skill he may need no instruction in his actual work, but every plant, shop or field group has its own peculiar techniques and methods, some of which may be different. Caution the sponsor to explain these differences if any exist.

4. Tell Him About the Company

If your company isn't one of the world wide "business empires," the new

Tell him about the company.

employee is entitled to know something about its size, history, products, relation to other companies, its marketing method, growth, and policies. Wait a day or two until the new man has had a chance to "digest," all the new facts thrown at him. Then take time out to inquire about his progress, let him ask questions, get a gripe or two off his chest, if any are bothering him. Then tell him about your outfit. Who is the big boss, the company president, if you please? To whom do you report? Is the company growing? What are the prospects for advancement? Attempt to clear up any misapprehensions which may be lingering in the new man's mind.

Even if your company is the best known in the industry the new employee may be entertaining wholly erroneous ideas about it. He may think it is a giant octopus, bent on devouring smaller competitors. Teach him to respect the company and its competitors as well. About this time come around to things such as paid vacations, sick leave, insurance, holidays, and other "fringe benefits," about which he may be curious. Remember this: The new employee is subject to the "grapevine," which exists in every organization. From this grapevine he may be picking up all sorts of half-truths, gossip, rumors and tall tales. It is amazing how many items of scuttlebutt flow through even in the very best managed organizations. The very least you can do for the new employee is to see to it that some of these tall tales and half-truths and bits of gossip are matched by the single truth about the company.

5. The First Payday

Even to old-timers payday is a glorious event. But to the new man, getting his first paycheck or envelope it is bound to be somewhat of a landmark in his life. Many skilled executives like to present each new employee with his or her first pay, using this opportunity for a friendly chat. It is especially important to use this opportunity to explain deductions, pay rates, Social Security, income taxes, old age benefits and all the other items which may appear on the check or envelope. Keep in mind that your new employee has somebody at home to explain these items to—wife, mother, father,—and they are apt to ask questions he cannot answer unless you patiently explain everything he needs to know.

At this interview attempt to draw out the employee and learn what progress he is making—not so much to reassure you, as the employer's representative—but to reassure him and bolster up his peace of mind if he needs it. One of the best employers in all my experience told me once that it is a good idea to impress the new employee that the company, the boss, the supervisor—all of them—want him to make good. Explain that it is a feather in the cap of the employment or personnel department, the foreman, the supervisor, the department manager—everybody when a new employee proves his value on the job. The old school of bosses used to put great store in a sort of "hazing" process whereby the new employee was challenged to show what sort of stuff he had in him. The newer school of management men believe this old "sink or swim" process is outmoded. They believe that the new employee requires patient counseling, friendly advice and leadership, and above all, a display of interest in his progress.

The boss wants him to make good.

6. The Right Attitude

Few, if any, organizations can boast of 100 percent employee loyalty. There has always been, and probably always will be a few soreheads in any organization. The men who are not quite bad enough to fire, and not good enough to promote are one type. Then there is the perpetual trouble maker, who takes a delight in telling all new employees just what's wrong with the organization.

These misfits can do a lot of harm to the new employee, and since every employee's worth to the organization depends in large measure upon his healthy attitude toward his work and his company, do everything you can to impart a healthy attitude in the mind of every new employee.

Turnover rates are high in most organizations because of "quits" which occur during the first six months after employment. If we can guide a new worker through the first six months we may make a valuable and permanent employee of him. During this period the new employee hears that some other company pays higher wages for the same work. He hears that "you'll never get anywhere unless you belong to the right lodge." He may also hear, the very next day that he'll never get anywhere unless he belongs to a totally different lodge.

The best, most valuable employees are inclined to mind their own business and leave the newcomers alone. It's the trouble makers who seek out the new employee to pour their woes, gripes and complaints into the ears of the new man.

The new man hears that the foreman or supervisor is partial to men from his former company—or partial to Swedes, Irish, or Dutchmen — whatever his nationality may be — he hears that the top dog in the department is a relative of the big boss, a friend of a big stockholder, or was put into his job by an important customer — oh, he may hear any such tale. Of course, if he's wise and intelligent and not too gullible these tales go in one ear and out the other. But enough of them sooner or later "get to him," and he's bothered and nervous as to whether or not he has selected the right outfit.

Do your share — give him at least as many positive *facts* as the malcontents give him rumors. And then hope for the best. ★ ★ ★

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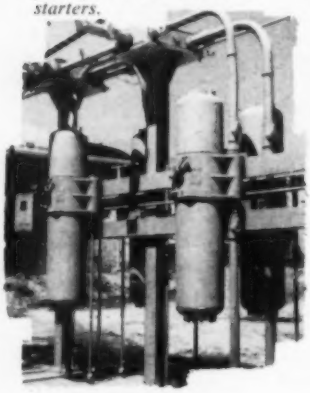

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Purchased Electric Power . . . saves money, manpower, maintenance and serves you better automatically

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How to Set Up a Five-Year Program

Long range planning gives your management a much clearer idea of where your company is going, how you're going to get there and when. Here are some practical ideas to follow by one who has tried them . . .

L. B. McKnight
Chairman Executive Committee
Chain Belt Company

THERE HAS, of course, been planning for company growth over all our 64 years but for the most part it was in people's minds and only discussed from time to time. Three years ago we put it on a formalized basis, and in so doing have been able to take advantage of specialized techniques available today in the commercial development field. Now long-range planning has become a formalized function and operates as a part of our jobs.

Because of our particular business we look upon long-range planning as a line responsibility. We do not, however, assign this responsibility to line people without specialized staff assistance. Like many others, we learned this the hard way. Our first effort at long-range planning resulted in a bundle of divisional plans, all of which were too rigid, in too much detail, and unrealistic. We over-planned, with the inevitable result that you are all familiar with, the plans were filed away, and after the enthusiasm wore off were more or less forgotten.

In our present procedure each division still has the responsibility for developing a divisional long-term plan, but they are all assisted by a central staff department known as the commercial development department. This is a three man department, with the manager reporting directly to the president, its principal functions being in the area of economic research, market research, new product investigation and directing and coordinating long-range planning.

This staff department helps the divisions work out their long-range sales volume forecasts and then in the end gathers up all the divisional plans, consolidates and condenses them for coordinated review and management approval.

In developing our five-year plan, we deal in four basic elements:

1. **Sales volume for our products for the next five years, by years.**
2. **Facilities required in the next five years for producing these sales volumes.**
3. **Divisional and departmental organization requirements for the next five years.**
4. **Financial requirements to cover capital investment and working capital for the next five years.**

Facilities, organization and finance generally all depend upon and flow from the first of the four — sales volume. So that is our starting point: Sales volume forecasts for five years.

As a basic guide, the commercial development department works up a five-year economic forecast. This is in broad terms designed to identify the approximate rate of change anticipated in certain economic indicators basic to our business. It is worked up into a concise report labeled "Economic Forecasts to 1962," and a copy given to every division manager. For our own business, charts and comment included cover the Federal Reserve Board Index, the Plant and Equipment Expenditure series, and Construction.

1. MARKET FORECAST

For their divisional five-year forecasts, each of our division managers follows four main steps.

FIRST, each manager examines his division by individual product lines, which will run from 3 to 14 in a division.

SECOND, the manager examines each product line from the standpoint of the principal end use markets it serves and tries to relate its trends to the trend for those end use markets.

THIRD, he considers the technological changes going on in the end use market which may affect the use of our products quite apart from the economic trend of that particular end use market.

FOURTH, an evaluation of our company's share of the market and possibilities for five years hence, always keeping in mind that perhaps our competitors are evaluating their share of the market also.

One highly important factor our division managers try to evaluate are the technological changes taking place in the end use markets of their products. For example, the pre-stressed concrete field is a new and rapidly developing one and represents a technological change in concrete construction which will have a direct bearing on types of concrete production equipment.

Most of you, I am sure, are familiar with the 25-mile bridge across Lake Pontchartrain in New Orleans. This is a concrete structure throughout but there was little or no yardage of concrete poured in place. All footings, beams and road slabs were pre-cast in a pre-stressed concrete shore plant. I can tell you that this technological change in concrete construction is being very carefully evaluated in our long-range equipment planning.

That's our general procedure for putting our five-year forecast together. Perhaps its greatest claim to your consideration is that it is a formalized method of building a forecast — embodying definite thinking about certain particular aspects of each product line.

Divisional forecasts are all submitted to our commercial development department where they are pulled together into the company total. This is done according to a deadline date — this date being again a part of a procedure. And it is done once each year — on the five-year basis.

In this way we review our five-year forecasts and all our long-range plans once a year, pushing out an additional year each time. We keep updating and in effect maintain a moving or continuous five-year forecast and planning.

2. FACILITIES FORECAST

Sales volumes call for productive capacity so the figures are next analyzed from the standpoint of facilities needed over the five-year period. On the central corporate staff, our vice president in charge of facilities works with the divisions, and a facility or capital plant and equipment program is worked out — timed by years.

Geography is another factor in facil-

Taken from a discussion before the National Industrial Conference Board, Dallas, Texas, March 20, 1958.

ity requirements which leads to the determination of the proper location of warehouses or branch plants.

Plant expansion, perhaps in another city, as you well know, takes a year or more to get built and moved into and shaken down into smooth operation. If production capacity for tomorrow's sales is to be in place and functioning when those sales are secured, that capacity has to be thought about today.

3. ORGANIZATION FORECAST

One interesting element of our long-range plan is organization. Here each division manager reviews his existing organization and in the light of the five-year sales volume forecasts, constructs an idealized organization chart for five years hence, showing new jobs that may have to be created as well as possible realignments in organization structure.

This one phase alone of our long-range planning has made the whole operation worth while. Divisional managers sometimes become too dependent upon general management to provide and train their manpower requirements. Now, with an organization diagram projected five years ahead, subject to a yearly review and revision, these divisional managers give much greater thought to the building of people in their respective divisions and, incidentally, in so doing, develop their own management abilities.

A major phase of organization planning is to project the size of our field sales forces five years hence to produce the forecasted volume. If we expect to increase sales volume substantially, it is important to recognize that we must first substantially increase our sales force.

Since five years is not too long for sound sales engineering proficiency to be developed, it is necessary to continue looking and planning ahead in this manpower requirement area. This phase of the plan then serves as a guide in recruiting for our college graduate training program.

4. FINANCIAL FORECAST

The financial element of our long-range plan likewise derives both from sales volume plans and from capital requirements set out in the facilities plan.

First, divisional P & L statements are drawn up and finally these are pulled together by our central corporate financial department into successive pro forma company P & L statements and balance sheets.

These in turn can be checked out to general objective ratios for return on sales, return on investment, earnings per share and dividends.

Similarly future needs for money can be shown up.

R & D Plans

One of our key departments, Research & Development, is a company-wide department set into the company at the corporate level and headed up by a vice president. The five-year plans give R & D guidelines both as to probable levels of activity — usually in terms of percent of forecast sales levels — and also trends of the different product lines. Further refinement into a R & D five-year plan comes from detailed discussions by the R & D people with our divisions and other executives.

Five-year plans are guides at best and have to be updated each year to maintain flexibility and validity. One authority has aptly stated that a long-range plan is more of a compass than a railroad time table.

Final Form

As evidence of this simplicity, here is our plan as it finally reaches the president — a 15-page report. It contains the following information:

1. Forecasted shipments – by products – by divisions — and by years for the next five year period up to and through 1962.
2. Employment forecast, both shop and clerical, for the current year and projected through 1962.
3. A schedule of contemplated facility requirements for each division for the five-year period.
4. Comparative profit and loss statements for the company, by years, for the next five-year period.
5. Comparative balance sheets for each year up to and through 1962.

At a time when we are all having great difficulty in forecasting accurately six months ahead, you may well ask, "How can you forecast five years into the future?" My answer to that is that we can't, at least with a high degree of accuracy, so that one of the basic elements of our plan must of necessity be flexibility.

New Products Planning

So far I have been referring only to our present line of products. I have made no mention of new products and yet new products have been and are a vital element in company growth and in forward planning.

You have to look farther ahead than five years when considering new products, and while it is a definite part of long-range planning it cannot contain the specifics that apply to long-range plans for existing products.

How It Helps

So finally, we have a long-range plan — What do we do with it and how does it benefit us?

1. It serves as a control device for top management to insure that broad company thinking and planning continues to conform to the company's business practices and philosophy.
2. It provides a framework within which the chief executive officer can be guided in his thinking and planning for the company's future. For example, if our present plan proves reasonably accurate, the pro forma balance sheets tell me that we will have to go into the money market probably some time in 1960. Knowing that, we might not wait until 1960 in event we get into a favorable market earlier. As I stated, we like, if possible, to get our future money needs ahead of time.
3. It provides a guide for addition or deletion of products. Like most companies, we find it more difficult to drop an existing product than to add a new one. In last year's plan a forecasted five-year decline of a product which had been declining for some years provided just the needed emphasis to discontinue it.
4. It provides a guide for personnel recruitment, training and organization planning, thereby helping to eliminate the need of filling jobs on an emergency basis.
5. It provides a background for expense control to insure that long term operations will not be jeopardized in order to show improved current operations.
6. Because it is set out as a growth pattern for the company, it serves as a morale builder for the younger management group.
7. Over and above these specific benefits — and there are many more — I think possibly the greatest, and one that cannot easily be measured, is that it develops the habit of organized planning at several levels of management.

Once each year we have a group review attended by all upper level management people. Each of the four phases of the plan — sales volume — facilities — organization — finance, are presented and reviewed by divisional managers, with changes outlined in view of developments, and a new fifth year added to the plan.

No matter how much the plan may be modified each year, I am satisfied that we are leaving less to chance. We are putting ourselves in better position to be doing business in the future when it arrives and all of our management people have a much clearer idea of where we are going, how we are going to get there, and when. ★ ★ ★

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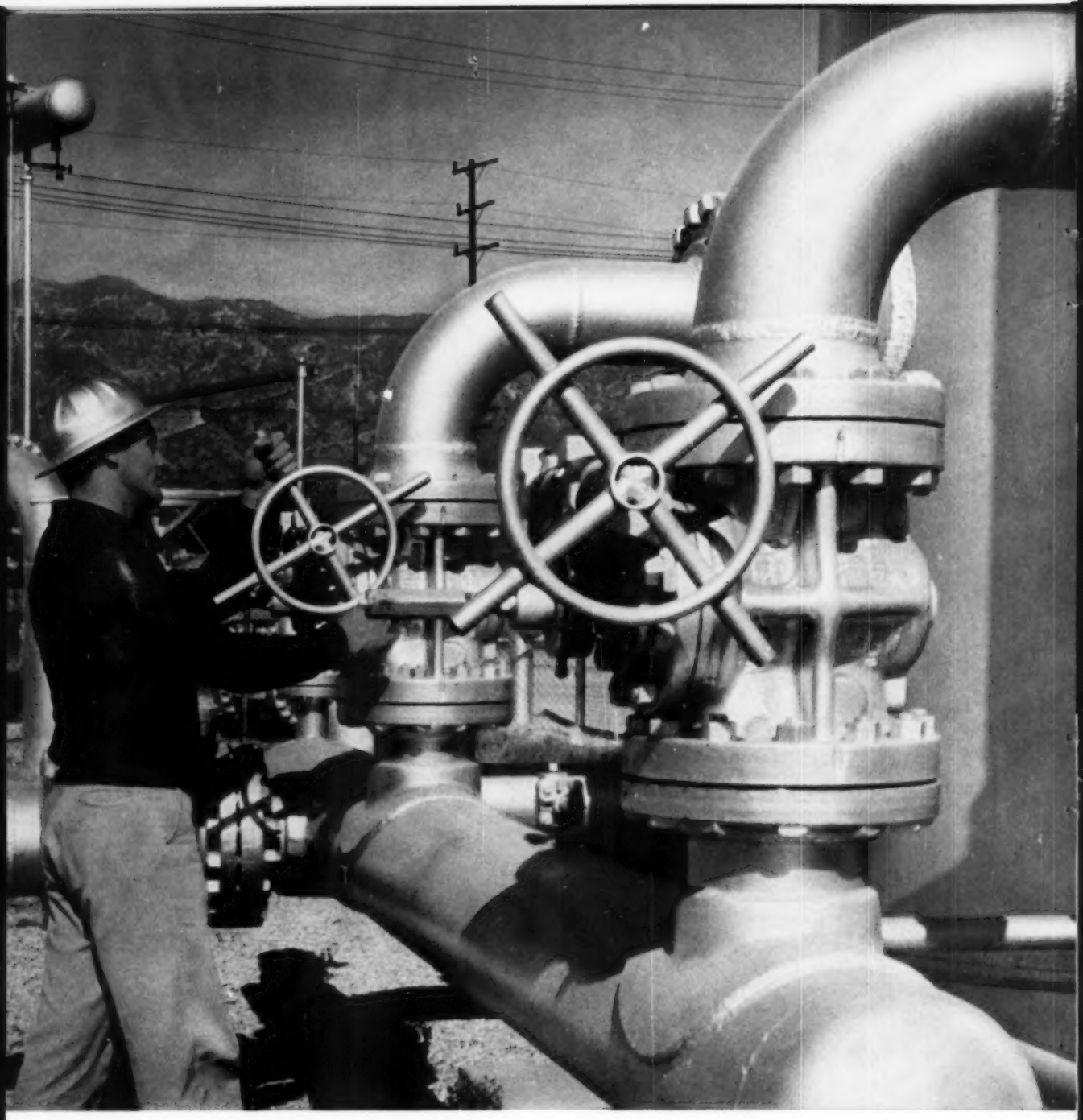

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ROCKWELL-Nordstrom VALVES

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MANUFACTURING COMPANY

Scott Nicholson

Authorship and Company Policy

In the advance of science and engineering, publication is second only to discovery. Scientific experiments and engineering operations must be published before they can be duplicated or corroborated. This tells how forty companies overcome literary lethargy. . . .

THE SCIENTIFIC literature† that a country produces is a good indication of the vitality of that country's science. There are several reasons why this is so.

One reason is that most productive experimenters, from Pasteur to Riemann, have tended to be voluminous writers. In a recent study of scientific literature, Nobel prizewinner, William Shokley, observes that "Studies demonstrate surprisingly close correlation between quantity of scientific production and the achievement of eminence as a contributor to the scientific field.*

Also, published articles bridge the information gap between scientists. They afford a means by which scientists working on the same problem in different labs can exchange information. And this process of keeping abreast of the latest developments is essential to current progress.

Finally, a vigorous scientific literature aids a country's long-range scientific growth. As E. K. Gannett, managing editor of the Institute of Radio Engineers points out, "Scientific writing renews thinking. By placing knowledge on record for 10 years hence, it preserves the germs of useful ideas so that someone later may pick up where the last researcher left off and pursue the idea along a new line of development. That's the way scientific progress occurs."

Cause for Concern

How is America doing in this important phase of science and engineering? A few years ago no one would have bothered to ask such a question. America and Western Europe stood almost alone as the chief contributors to the literature of science. However, if the latest reports from the Academy of Sciences of the USSR† are to be believed, the Soviet Union is rapidly overtaking America in both the publication of original manuscripts and the abstracting of scientific journals. Last year the All Union Institute of Scientific and Technical Information, Russia's scientific information center, boasted that it furnished complete coverage of 400,000 papers to Russian scientists. Though the majority of these may be translations of back-dated Western papers, nonetheless, contrasted against the fields of electronics, chemistry and mechanics in the United States last year, this figure must give American scientists pause. The Western World's output of meritorious scientific writing is even smaller. Last year, the Department of Scientific and Industrial Research in London, the Western World's major center of scientific literature, reported that it abstracted 3900 papers of special merit produced in America and Western Europe, of which less than half were authored by Americans.

The Role of Business

Is there any explanation for this lag in America's intellectual efforts? Interested observers here have come forth with several answers.

Many place the blame on government security regulations. The Defense Department and the AEC, this argument goes, have classified the very information which is most needed. One scientist at the Army's Redstone Arsenal — cleared through top secret — pointed out to a reporter that the best way to maintain one's access to classified information "is *never* to publish."

But probably the brunt of the blame is being borne by that standard whipping boy, the U. S. corporation. Informed engineers have accused companies of unintentionally interfering with the publication of scientific literature. One widely held view, for example, is that public relations and sales departments turn most technical writing into promotional literature. As an official of the Grand Central Rocket Company, Redlands, California, points out, "Engineering articles should be purely for information and not oriented toward the interest of sales. When they are directed toward sales, the information becomes slanted and impedes the scholarliness of the articles."

Researchers also complain that companies encourage scientists and engineers to be secretive about new processes and inventions. As George A. Stetson, editor emeritus of the ASME journal says, "Just two decades ago the incentive was all toward publishing. The scientist made a reputation for himself in his field by writing papers. Today most men seem to get ahead in their company by inventing, but being very careful not to disclose any of the processes and products that result. Today the incentive is all toward nondisclosure of secrets rather than disclosure."

Finally, companies are accused of depriving scientists of the incentive and time to produce literature. Technical men, this argument says, are kept

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Reprinted from Research and Engineering, April 1957.

†These include engineering reports as well as more theoretical science as you will see.

*On The Statistics of Individual Variations of Productivity in Research Laboratories. — *Proceedings of the I.R.E.*, Volume 45, No. 8, March 1957.

‡You will note this was written in April, 1957, *before* Soviet Sputniks brought many such comparisons.

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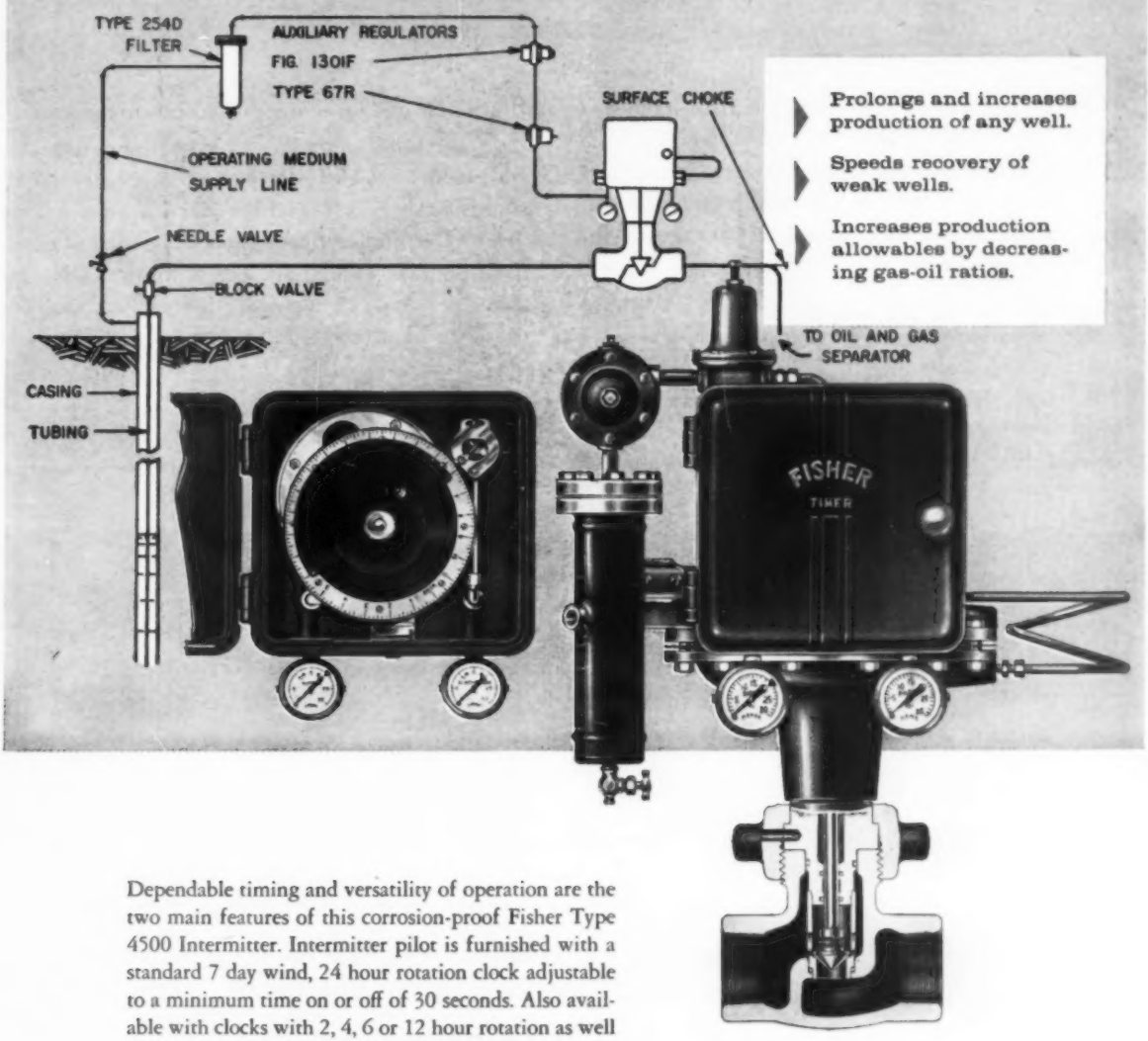

- Prolongs and increases production of any well.
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Dependable timing and versatility of operation are the two main features of this corrosion-proof Fisher Type 4500 Intermitter. Intermitter pilot is furnished with a standard 7 day wind, 24 hour rotation clock adjustable to a minimum time on or off of 30 seconds. Also available with clocks with 2, 4, 6 or 12 hour rotation as well as clocks with electric drive. Reverse action can be easily achieved by simply rotating relay cap 180°. Complete information is available on the Fisher Type 4500 Intermitter by requesting Bulletin O-4500.

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18 Cat Engines demonstrate power and versatility for offshore drilling operation

Continental-Emsco Company, Dallas, Texas, used Cat power right up the ladder—from the compact D311 to the mighty D397 Engines.

If yours is a drilling operation, you'll be interested in this display of versatile Caterpillar power. From compact diesel electric sets to modern, heavy-duty diesel engines, there's a Cat unit power-right for your needs, either as a complete package or for special installations.

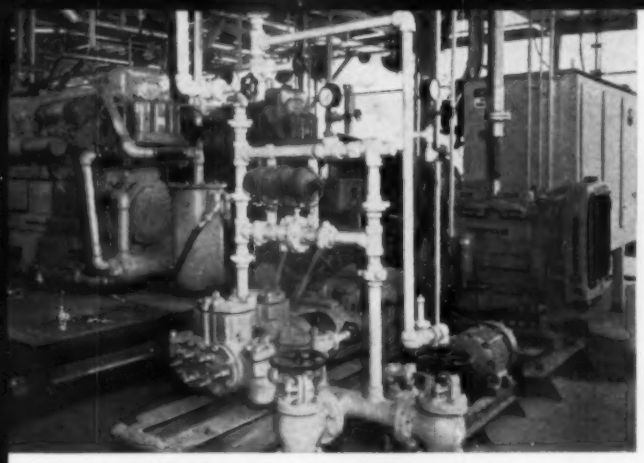
Continental-Emsco recognized that Cat power makes good sense and used Caterpillar Engines for the Lake Maracaibo Drilling Tenders they build for "in stock" delivery. C-E knew that easy accessibility and interchangeability of parts, as well as dependable, 'round-the-clock service, mean less down time and lower operating costs to the operator.

Your Caterpillar Dealer has Cat Engines available from 65 to 650 HP (maximum output capacity) and Electric Sets from 30 to 350 KW (continuous). And a Cat Engine Specialist will be glad to discuss your operation with you. Get in touch, today. He's as near as your telephone. Remember, too, when you order oilfield equipment, specify the power that's matched to the heavy-duty equipment . . . always specify Caterpillar.

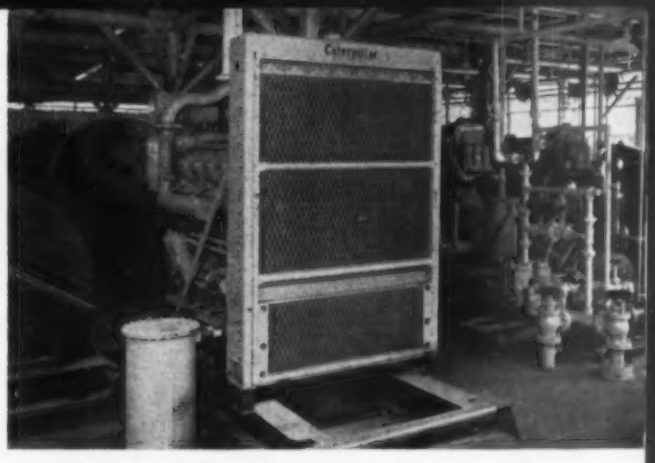
Engine Division, Caterpillar Tractor Co., Peoria, Ill., U. S. A.

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

Continental-Emsco Company, Dallas, uses 18 Cat Engines for auxiliary and prime power on the two Lake Marccaibo Drilling Tenders shown here. The tenders are 180' long with 70' beam and 11' 3" draft. Each is equipped with a helicopter deck, 45' x 83'.

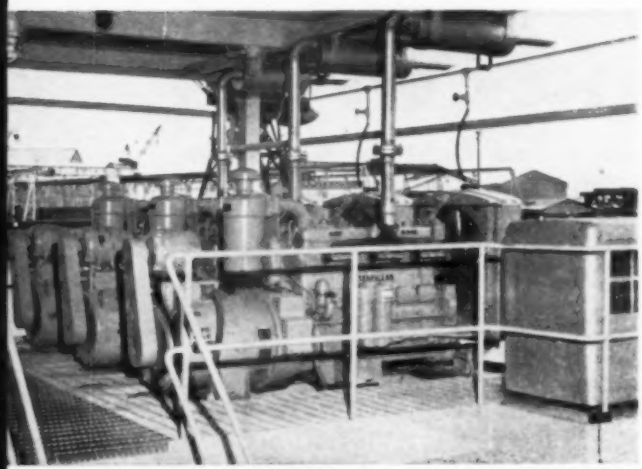


A modern, heavy-duty Cat D311 Engine (right) drives a Gardner-Denver FG-FXG 5" x 6" pump on each tender. These Cat-powered duplex pumps supply raw water for washing down rigs and keeping tenders clean.

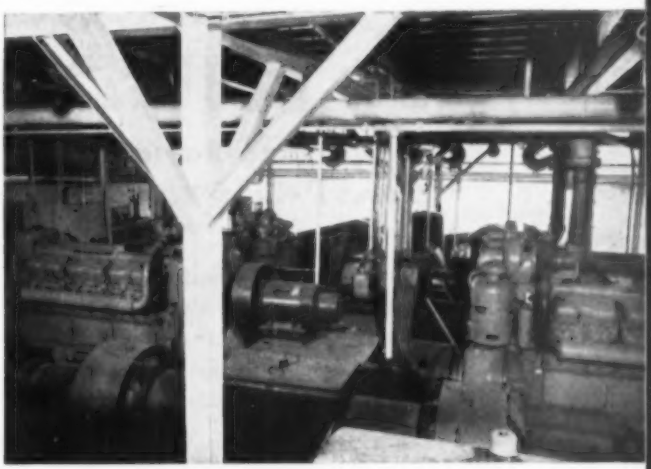


Here a Caterpillar Diesel D375 Engine supplies power for a Gardner-Denver mud pump on each tender. Continental-Emsco Company finds the D375 an excellent power-match for the 7¼" x 14" Model FK-FXK pump.

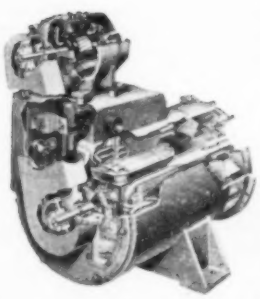
ENGINE POWER BY CATERPILLAR



Three Cat D318 Diesel Electric Sets provide all A.C. electric power for each tender. Uses include excitation for the D.C. rig drive equipment, the generator and motor blowers, mud mixers, water and fuel pumps, and lighting for rig and living quarters.



Four turbocharged Cat D397 Diesel Engines drive Continental-Emsco "Del Lago" type compounding transmissions on each tender. The rigs, intended for service on Lake Maracaibo, Venezuela, have a drilling depth of 12,000 to 15,000 feet.



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Engine Division, Dept. PE8
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☐ Have Caterpillar Dealer call for an appointment as I may be in the market. I understand that I am under no obligation.

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New RIDGID Hex Wrench

gives you Time-Saving, Positive, 4-Sided Grip on Hex Nuts, Square Nuts, Valve Packing Nuts, Unions, Gas Cocks

Here's the adjustable wrench you've always needed for hexes, squares and flatheads, rough or finished. Extra-useful on every job. No more skinned knuckles or rounded nut shoulders. New wide-open jaw goes on easy . . . won't slip off. 4-sided grip gives extra leverage. Stays to adjusted size during use.

Famous RIDGID heavy-duty construction with guaranteed housing. Narrow jaw design makes work easy in tight places even on thin nuts. Comfort grip I-beam handle has handy hang-up hole. The new RIDGID Hex Wrench gives you more for your money than wrenches costing twice as much. Try it, buy it at your Wholesaler's.

Available in 3 Sizes
- No. 11, 3/8" to 3/4"
- No. 17, 5/8" to 1 1/4"
- No. 25, 1" to 2"

The Ridge Tool Company • Elyria, Ohio, U.S.A.

Authorship & Company Policy

so busy producing research for the company, that in many companies there is no time for individual work. Credits for publication must be given to the company and to other non-writers before companies will approve the publication of the paper.

R/E's Survey

How valid are these criticisms? To find the answer, *Research & Engineering* some time back polled 40 companies in many parts of the United States regarding their publication practices. The results of this survey reveal that these complaints are for the most part unjustified. Actually, companies in research and development are doing what they can to help their engineers get experiments into writing. Eighty-one percent of the responding companies reported themselves actively encouraging their engineers to write for publication.

From the standpoint of patent protection, keeping new discoveries secret is not always advisable. Many companies deliberately encourage their engineers to publish new inventions in order to reinforce their claims of patent priority. The patent department of the M. B. Manufacturing Company of New Haven, Connecticut, for instance, insists that its engineers publish as soon as possible after developing a product or process because, in patent law, prior publicity is nine-tenths of ownership.

Finally, the belief that companies are discouraging individuals from publishing is refuted by the 43 percent of companies. They see the main advantage of writing to be the improvement it works on the thinking and expression of the individual engineers. For example, Dr. W. E. Hanford, vice president of Petroleum and Chemical Research of the M. W. Kellogg Company says that, "Only through publication does an individual maintain his own high technical standards." And Dr. T. H. Rogers, director of research for the Standard Oil Company, points out that "Authors of papers for publication write better reports. They need the experience of organizing and writing for a wide audience."

In short, this poll of 40 companies indicates that American industry is very concerned with the problem of increasing the number of technical articles written for publication. Only 20 percent of the respondents reported doing nothing to promote writing of scientific literature. The great majority are pushing positive programs to encourage engineers to write for publication.

How do they go about this? The replies to the poll indicate most companies meet the problem by one of three systems.

- **an engineer writing fund**
- **a professional editing service**
- **a publications committee.**

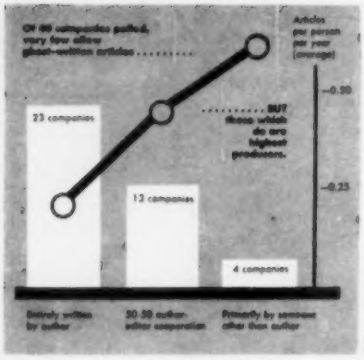
Writing for Money

According to R/E's survey, some companies have established writing funds to induce engineers to write. The company pays its authors a fixed fee for a minimum number of words. In most cases, in order to get paid, the author is required to do the writing on his own time. Also, the subject of the article must be about something other than his normal work.

The advantages of an engineering writing fund are set forth as follows by the Convair Company of San Diego, California:

"Under the former system, we found engineer-authors tended to slant their writing toward the periodicals which paid the largest fees, with the result that papers were being submitted to relatively few editors, and not always to the publication best concerned with the article subject. Since, in Convair, payment to the author is standardized — at a price comfortably above the going rate (we found the average honorarium well below $100 per article) — the author can submit articles without regard for financial return to the most suitable publications.

Non-disclosure of secrets is the tendency today.



Of forty companies polled, very few allow ghost-written articles . . . But those that do are highest producers.

"From our standpoint the system has worked very well. In the half of 1956 during which the fund was actually in operation, we authorized more than twice the number of payments for which we had budgeted at the outset. And in that half year more than doubled the number accepted by reputable magazines during the 12 months prior to the May starting date of the fund. Also paying men for writing gets the writing done."

"If the article can be paid for in cash," adds the Director of Research of the Electro Refractories and Abrasives Corporation of Buffalo, New York, "the men will write on their own time — otherwise not."

Most companies, however, look upon writing funds as a needless expense. Said the chairman of the publications committee of a midwestern chemical company: "The men who write for money, I don't believe produce as high quality work as those who are motivated simply by the reputation in their field."

A somewhat different objection is expressed by an official in the American Machine & Foundry Company, who argues that paying money for articles simply takes men away from their regular duties. "If we gave money for writing articles," he laconically commented, "that's all those guys would ever be doing."

Finally, many companies feel that the problem is not to stimulate quantity of scientific literature but to stimulate quality. Said the research director of a North Carolina textile company, "There are very few really significant articles written. And the real trouble seems to me to be in improving the writing quality so that men will not have to dig and sweat as hard in eking the few morsels of information out of an overstuffed article."

Help from Editors

How can companies improve the quality of writing? Many companies answer by hiring professional technical writers. These men, usually amateurs in science, are specialists in language. They work exclusively on polishing the writings of engineers. They may be on the public relations staff or members of technical writing divisions.

Companies find that such men are useful in several ways. For one thing, they frequently produce more readable reports. Because the technical editor is a specialist in writing, he often knows how to express ideas simply and clearly. Also since he's a layman, he is more aware of points that are difficult to understand. As a result, the work he edits is frequently well received by the average audience.

Another advantage of the technical editor is that he can help engineers to meet their writing deadlines. Because he works exclusively on writing, he's not diverted by other activities. Thus, he can push ahead on writing projects much faster than can the engineer, who is often overloaded with the demands of his work.

Finally, many companies feel that having a technical editor on the staff saves money. The technical editor's time is less valuable than the engineer's and he can serve the writing needs of several engineers simultaneously and save the overall time investment of these men.

However, many research and development managers see decided disadvantages in the use of technical editors. For one thing, reliance on them too frequently evolves into out-and-out ghost writing. This means that the engineer authors his articles in name only.

Since one of the most significant values which an engineer receives from writing for publication is the practice he gets in clear and orderly expression of ideas, many research and development managers feel that the engineer loses this training if an editor takes over the task. Says Dr. T. H. Rogers, director of research for Standard Oil Company, "Authors of papers for publications write better reports also, and they need the experience." An official of Philco Company adds, "In these days of cluttered communication channels, the clarity with which technical ideas are expressed can have considerable bearing on the size of the clutter."

Ghostwriting also reduces the pride of authorship. A West Coast airplane company points out that writing for publication furthers an engineer's reputation; the realization that another man has done much of the work diminishes this pride.

One or two companies point out the possibility that technical editors, who are not well-versed in technical matters, may make embarrassing mistakes and bring possible loss of sales to the company.

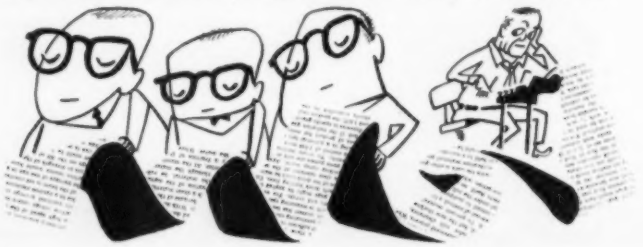
Publications Committees

How can companies avoid such errors and still make use of technical editors? One way, which over 54 percent of the respondents are employing, is through the use of publications committees to review the literary efforts of engineers. Men from various departments are represented on these committees. They are responsible for assigning articles and reviewing manuscripts. They meet from time to time, sometimes once a month, and bring to each manuscript the accumulated experience of their various backgrounds.

These publications committees are popular for three reasons. One is that they diminish the chance of errors. Just as important, they stimulate interest in writing by providing an immediate audience for the author. Also, because he knows that the manuscript will go the rounds right away, the author tends to polish his work beforehand. Finally, as one highly placed official in a chemical company points out, "Committees are a necessity in a company like ours, where the engineers are producing plenty of articles of various levels of competence. The committees provide a method of fairly assessing the articles for value and determining priorities — which articles should be published first and which are of secondary importance."

On the negative side are the standard criticisms of committee management which arise from time to time. The members of publication committees are frequently not familiar enough with the subject of the manuscript to be qualified to review it. Sometimes the comments on the margins of the manu-

Publications committees provide an immediate audience for the author.



BEAIRD-INGERSOLL-RAND Packaged Compressor Plant

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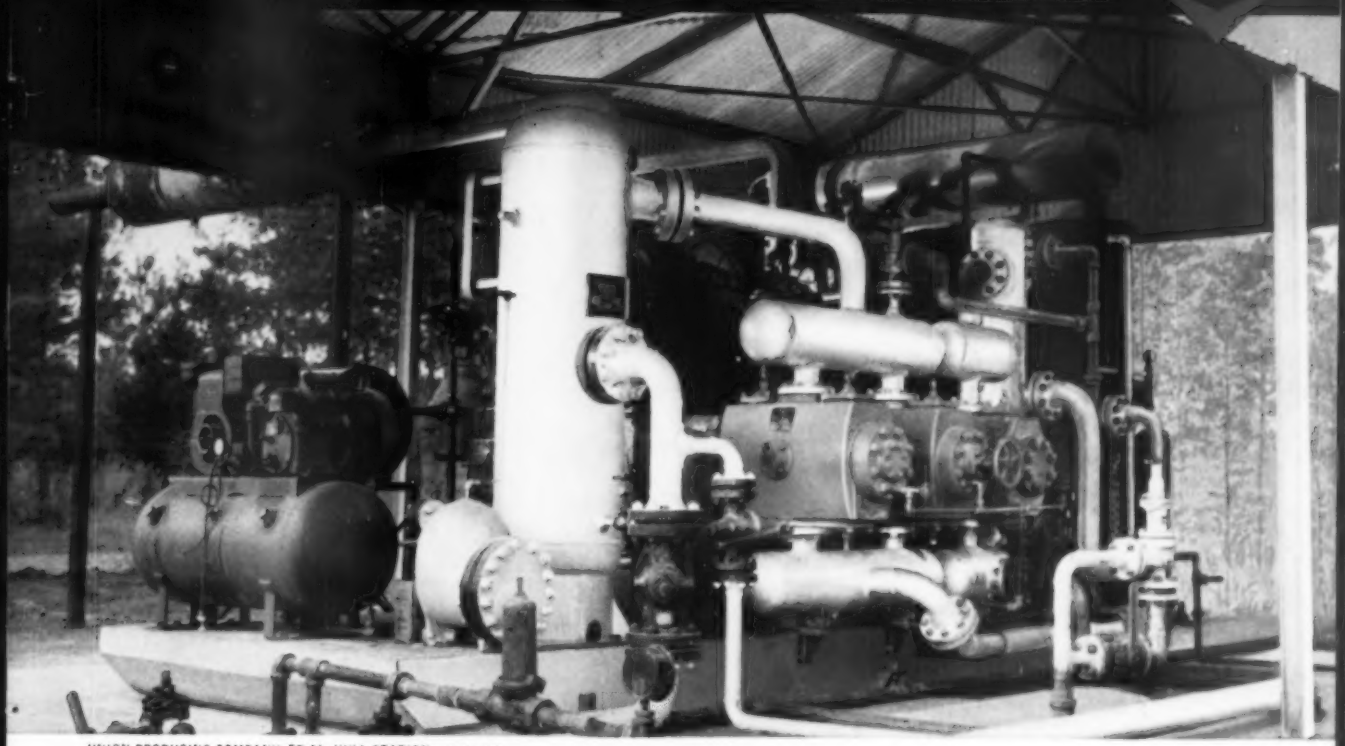

UNION PRODUCING COMPANY, ET AL, HULL STATION—equipped with a Beaird-Ingersoll-Rand 165 h.p. 6JVG Packaged Compressor. Unit has a Young Radiator with gas interstage, lubricating oil and engine cooling sections. Other Beaird compressors from 120 to 660 h.p.

Unit on Second Service—

FIELD CONVERSION FOR TWO STAGE OPERATION

Union Producing Company, et al., installed their Hull station in 1953 to boost gas in the Carthage Field. Consisting of one Beaird-Ingersoll-Rand 6JVG, 165-h.p. packaged compressor, the station handled 5.9 MMcfd with suction at 800 psig and discharge at 1300 psig.

During five years of production field pressures steadily declined until the original compressor could no longer operate efficiently. Rather than install a new unit it was determined that field conversion of the present compressor to two-stage operation would prove equally effective. This was quickly and economically done in the field. Two 7½-inch cylinders were placed on the first compression stage and a 5-inch cylinder on the second stage. Interstage gas cooling was provided by adding a gas coil at the front of the existing radiator. A scrubber for the second stage was installed and clearance bottle connections were provided on all cylinders.

The unit is now back in operation handling 2.5 MMcfd with suction at 100 psig and discharge at 300 psig. This field conversion will enable the unit to operate fully loaded down through final production of the field.

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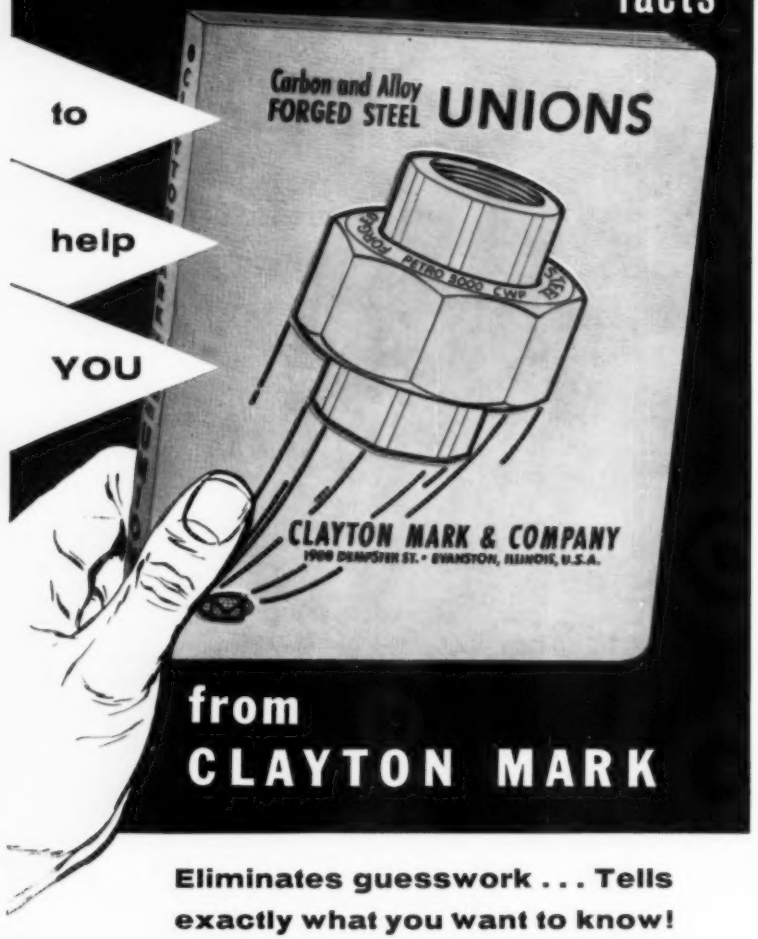

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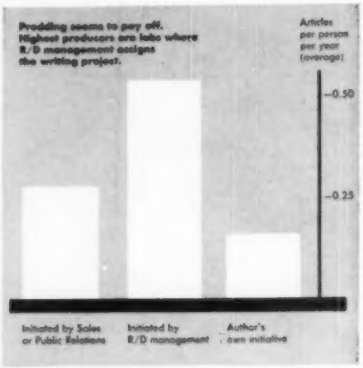
Prodding seems to pay off. Highest producers are labs where R/D management assigns the writing project.
Articles per person per year (average)
0.50
0.25
Initiated by Sales or Public Relations
Initiated by R/D management
Author's own initiative

Prodding seems to pay off . . . Highest producers are labs where R/D management assigns the writing project.

script are a deterrent rather than an encouragement to further writing. In addition, frequently no one takes responsibility for seeing that the publications are mailed out to magazines. When a technical writer is available, there is always one individual to ride herd on articles and see that a specified number are distributed. In committees, with each of the members too busy to give it his full time, this activity is often ignored.

How About the Time Element?

Seventy-five percent of R/E's respondents agreed that time is one of the main obstacles to the production of scientific literature. Handy & Harmon reports, "The problem is to get the job done. The result is that the author works on the report during and after hours." And J. Bennett Hill, director, the research and development department of the Sun Oil Company in Philadelphia says, "Though it's accepted that the engineer may write on company time, actually most of this work is done on his own time."

A great number of companies, 51 percent, make allowance for this lack of time by permitting engineers to do some of their writing on company time unless a special project intervenes. The truth is, however, that special projects arise so often in most labs that engineers have little if any time to write during office hours.

Quality the Main Concern

Perhaps the best appraisal of the scientific literature being produced in America today was made by Ralph Phelps, director of the Engineering Society Library, who commented, "Measuring writing in terms of quantity is pretty meaningless. The important thing is that scientific literature be written with a view toward teaching and informing, not just to place one's paper before a meeting." ★ ★ ★

Management Personals

T. L. Wark

▸ Vice President **Thomas L. Wark** was appointed special assistant to the president of Tidewater Oil Company. Wark was formerly western division general manager, with headquarters in San Francisco. Vice President **Charles R. Brown** has been named western division general manager, succeeding Wark. Brown's prior post was central division general manager in Tulsa. **Lloyd Armstrong,** previously southern division assistant general manager, with Houston headquarters, has been appointed central division general manager, succeeding Brown.

C. R. Brown

Lloyd Armstrong

▸ **Jack McLaughlin,** former night editor of the Los Angeles International News Service Bureau, has joined the press relations staff of The Superior Oil Company. As part of his new duties McLaughlin will help edit Superior's new house publication, *Superior View*.

▸ **Frank M. Jacobson,** vice president of Murphy-Canada Oil Company, was elected president and a director of Amurex Oil Company, and **Paul C. McDonald,** vice president of Murphy Corporation, was elected an Amurex director. They succeed **W. L. Falconer,** former president and director and **Oliver H. Payne,** former director, who have resigned.

DEATHS

▸ **Roy Warrington Henderson,** 46, vice president and assistant general manager of Baker Oil Tools, Inc., passed away June 24, in Houston, Texas.

▸ **Ralph M. Barr,** 58, who was widely known among oil men in Pennsylvania and Ohio, died suddenly June 24. He was manager of the Ohio shops district of The National Supply Company.

▸ **U. V. Seales,** 62, a vice president and the secretary-treasurer of Hunt Tool Company, died in Houston June 17.

▸ **William J. Healy,** 60, sales manager for the blower and compressor and the turbine divisions of the De Laval Steam Turbine Company, died June 3 in Trenton, New Jersey.

▸ **C. Frank Redick,** 76, who until his retirement in 1945 was the Ohio Oil Company's production superintendent at Yates field, Texas, died June 26, at his home in Spencerville, Ohio.

▸ **Louis F. Pemoulie,** 62, retired general superintendent for Atlantic Pipe Line Company's crude oil pipe line division, died of cancer May 14.

▸ **D. W. Brisbane,** chairman of BP Refinery (Kwinana) Ltd., was awarded the C.B.E. for public services in Australia. Also awarded the C.B.E. was **A. W. G. Trantor,** for public services in Aden, where he had been general manager of BP's Aden Refinery since 1954. The M.B.E. went to **A. L Bannister,** training manager of Kuwait Oil Company.

▸ **Ed Parkes,** executive vice president of United Gas Corporation since 1955, was appointed president. He is also president of Union Producing Company and United Gas Pipeline Company, the United Gas production and transmission subsidiaries. Parkes succeeds **N. C. McGowen,** who will remain as chairman of the board, a position he has held in addition to the presidency for several years.

Three Houstonians were re-elected as officers of the Texas distribution division of United Gas Corporation. They are **J. C. Flanagan,** vice president and general manager; **James A. Wilson,** vice president and operating manager, and **H. A. Lang,** assistant secretary and assistant treasurer.

▸ Admiral of the Fleet Sir **John Henry Dacres Cunningham,** G.C.B., M.V.O., M.I.I.E. (Hon.), chairman of the Iraq Petroleum Company and associated companies since 1949, has retired.

▸ **Harry F. Huf** was named general manager of the engineering and construction department of The Atlantic Refining Company. He has served as administrative manager for the past 4 years. Huf succeeds **Dr. L. M. Goldsmith,** retired.

▸ **William Naden** has been elected president of Esso Standard Oil Company following the announcement that **Stanley C. Hope,** president since 1949, has retired. Naden has been a director of the company since 1946 and executive vice president since 1955. Hope will devote a considerable portion of his time in the future to highway safety.

William Naden

S. C. Hope

▸ **Neville G. Penrose,** head of Neville G. Penrose, Inc., of Fort Worth, Texas, has agreed to serve as a vice chairman of the 1958 Special Gifts Campaign of the National Conference of Christians and Jews. Penrose will head the work of securing large gifts among members of the petroleum industry whose leaders are sympathetic to the cause.

▸ **George E. Mays** was assigned to Hamburg, Germany, as assistant to **L. W. Finlay,** shareholders' representative for Standard Oil Company (New Jersey) in Germany, Belgium and The Netherlands, and chairman of the company's coordination committee for Europe. Mays has been with Jersey Standard at its New York headquarters for the past three years.

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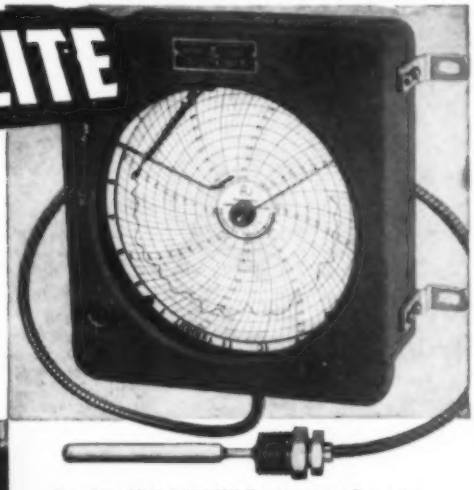
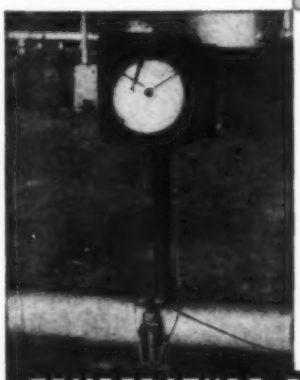
One of the many uses for Auto-Lite Recorders is the application shown below . . . a natural gas field meter run.





Auto-Lite Model "1000" Temperature Recorder has 6" chart. Various standard ranges from minus 40° F to plus 550° F. Available for wall mounting, portable or portable self contained use. Electric or mechanical chart drive. Choice of 24-hr. or 7-day cycle. Capillary tubing permits remote reading. Priced as low as $49.50. Manufactured to customers' specifications. Send for latest Catalog describing many types of Auto-Lite Recorders and Indicators.

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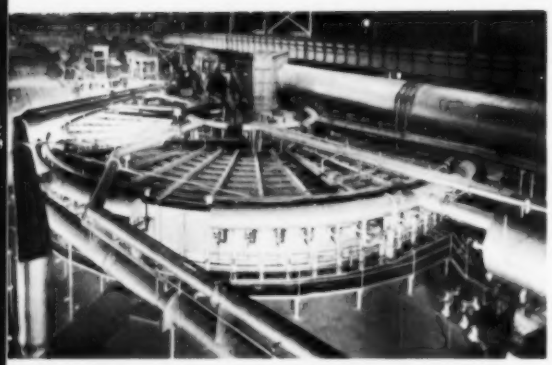
WHEREVER YOU FIND PIPE WITH ORANGE BANDS YOU'LL FIND A SMART PIPE BUYER



Youngstown's fully-automated ultra-modern No. 3 Seamless Mill now operating at our Indiana Harbor Works near Chicago . . . turns out the pipe with orange bands, the finest made anywhere. Illustrated is the world's largest Rotary Hearth Furnace . . . here three billets per minute are heated so that quality seamless pipe can work for you on your next drilling job!

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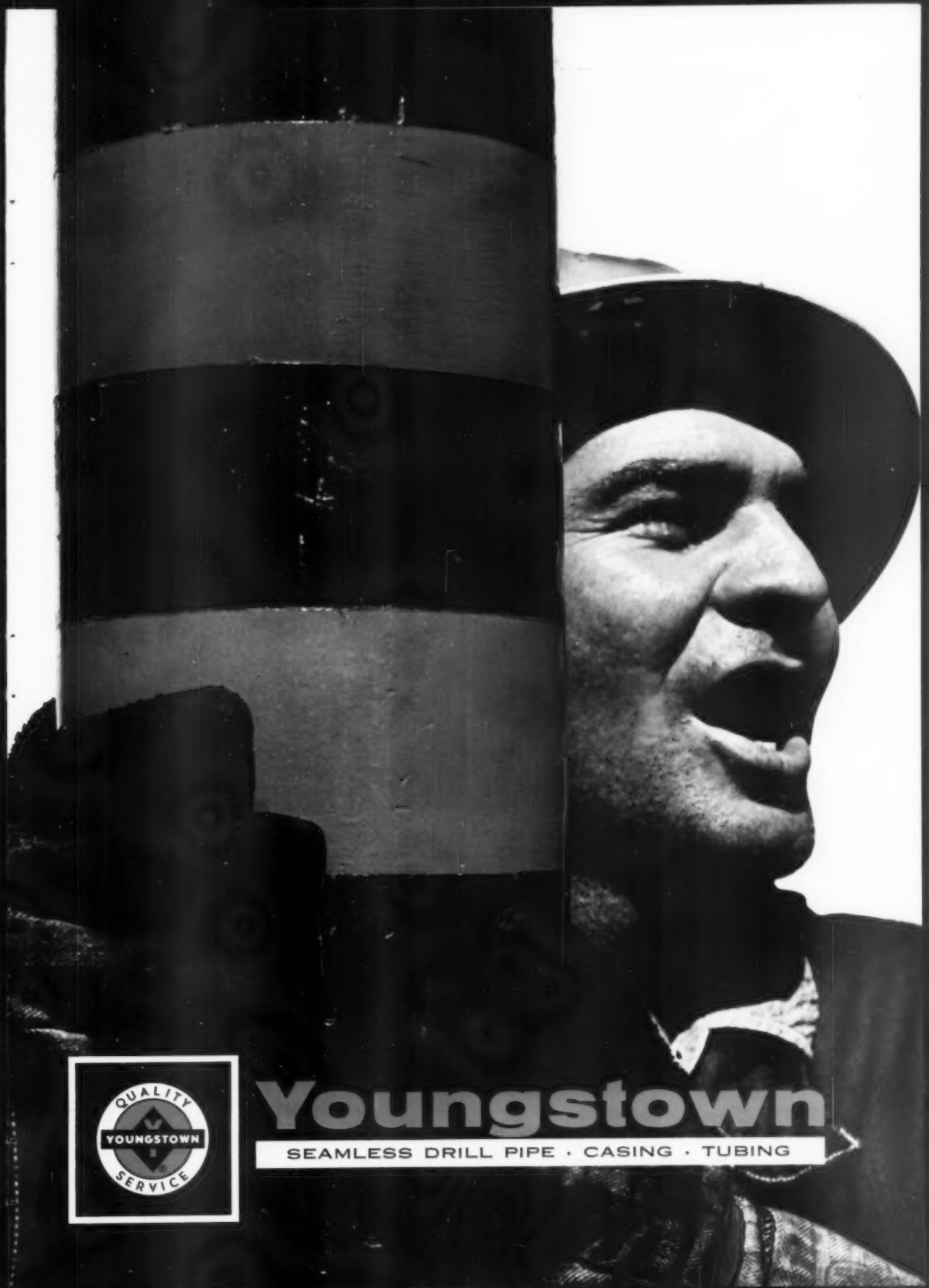
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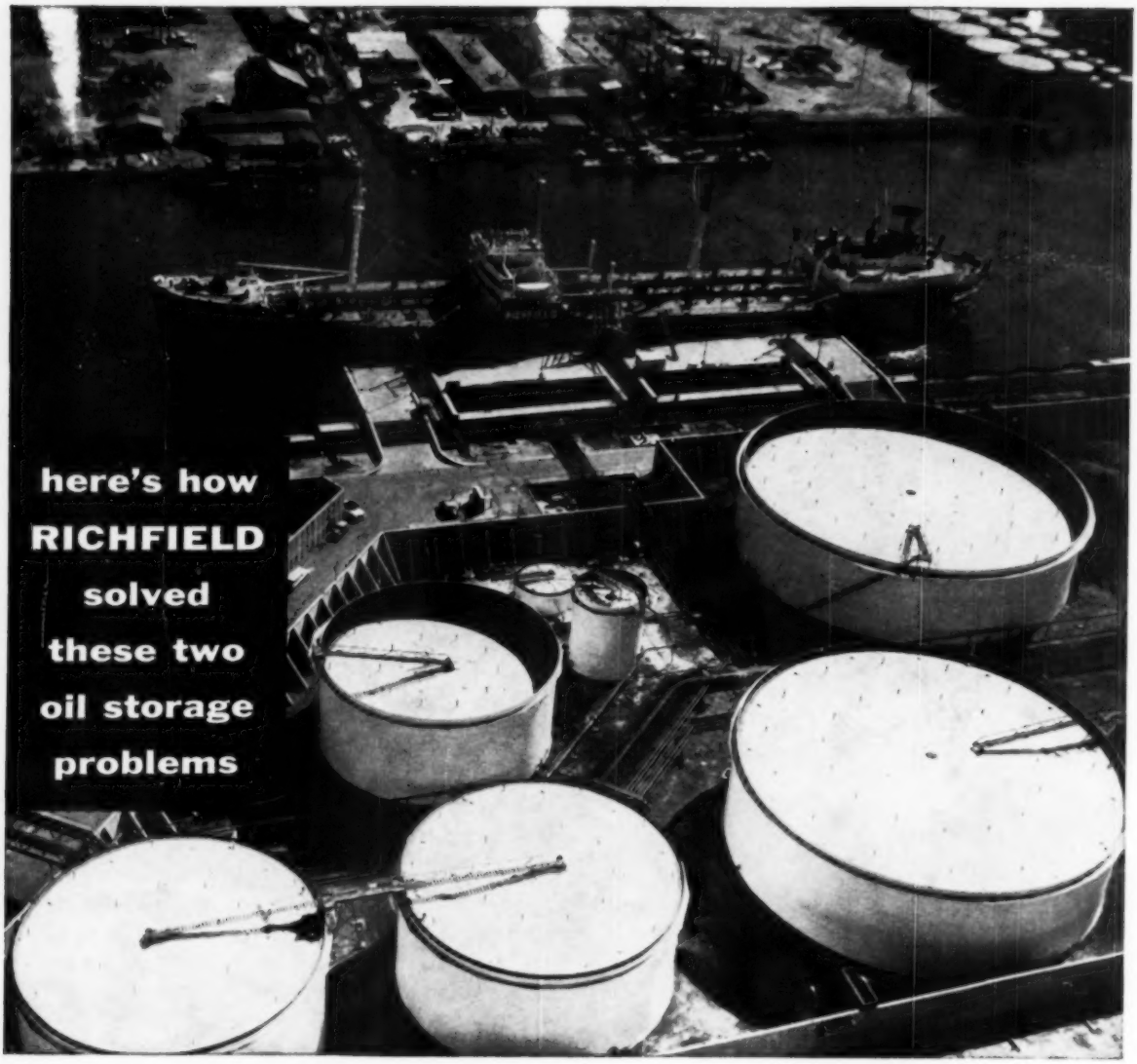

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Here is an investment by Richfield Oil Company that pays off in safety and conservation. It is a seven-tank addition to Richfield's Marine Terminals that adds half a million barrels capacity. The tanks, built by General American, are equipped with Wiggins Floating Roofs with Wiggins Safety Seal that stops vapor loss and protects from rim fires.

Wiggins Double-Deck Floating Roofs with the Wiggins Safety Seal, reduce vapor space under the circumferential fabric to an absolute minimum. This practically eliminates losses due to thermal breathing and serves to prevent rim fires. The fabric is of a new, long-lived type and a special weather-hood protects it from the sun. The seal mechanism is always out of the liquid and the corrosive vapor space. Only the Wiggins Safety Seal gives you all these advantages.

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New transistorized power supply for both transmitters and receivers means no vibrators to replace, no rotating or vibrating parts to wear out. Transistors, plus high quality silicon rectifiers, give you the most dependable mobile communication known today.

Progress Line mobile radios with transistorized power supplies are available in *all* communication bands: 30 to 100 watts in low band (25-54 mc), 25 or 50 watts in high band (144-174 mc), or 15 watts in UHF band (450-470 mc).

OPERATE FROM EITHER BATTERY POLARITY—Only General Electric's Progress Line lets you operate on either positively or negatively grounded 12 volt batteries. This is especially important in fleet operations.

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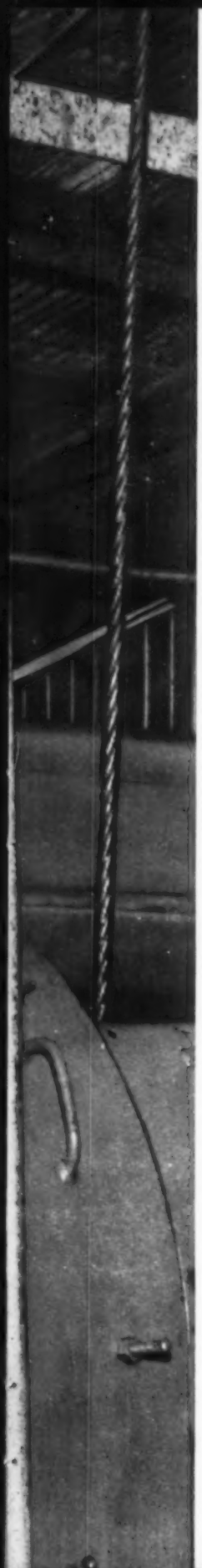
Howard Williams, driller, says, "We've had no trouble with Tiger Brand Lines—they've got the stuff to last."

Helmerick & Payne Rig No. 38 drilling with 7500 feet of Tiger Brand Rotary Drilling Line.



"We get better service from this wire rope than any other make,"

says **Howard Williams,** driller from Helmerick & Payne, Inc.

—It's Tiger Brand, of course

This rig was drilling in Garvin County, Oklahoma, when these photographs were taken. They were using a 7500-foot, $1\frac{1}{4}$" 6 x 19 USS American Tiger Brand Rotary Drilling Line with wire core.

This is the line that has set some of the highest ton-mile records in the oil fields. The driller, Mr. Howard Williams, said, "We've had better service with American Tiger Brand than with any other rope we ever used. It spools easy and we seldom have to add lubrication."

Helmerick & Payne, Inc. have used Tiger Brand Rope for many years. They operate more than twenty rigs. By following recommended cut-off practices and taking proper care of the rope, they get maximum service and low wire rope costs.

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• News • People — The Trade PARADE

CONSTRUCTION of a new building which will house additional seamless tubing and other cold draw equipment and facilities, and which will increase existing cold drawing production capacity by about 50 percent, principally for Monel, was announced by E. M. Kline, general manager of The International Nickel Company's Huntington, West Virginia, Works.

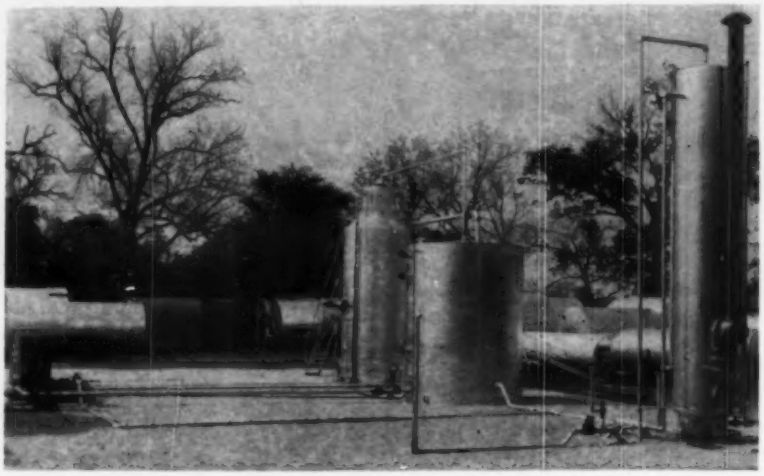
Costing about $3,500,000, the new building will be approximately 180 ft by 350 ft, and will house the necessary equipment for the efficient production, inspection and testing of long length high nickel alloy tubing.

SPERRY WESTERN, Inc., non-destructive testing service, is now in new and larger quarters at 1525A North Post Oak Road, Houston. The new home, consisting of a 4000 sq ft laboratory and test building, and 1200 sq ft office building, is about three times larger than their former location. The company has installed ultrasonic immersion equipment for conducting laboratory tests for detecting defects in various types of oil industry equipment.

NEW AUTHORIZED distributor of Du Mont's industrial television product line for 47 counties in the northeastern section of Texas is Sound Engineering Company of Dallas, Texas.

Located at 4329 Belmont Avenue, the industrial television specialist firm has been given exclusive rights for the sale, installation and servicing of Du Mont closed-circuit television systems in a market area whose leading cities are Dallas, Waco, Marshall, Sherman, Paris and Tyler.

WELEX, INC. has recently graduated 13 men representing U. S., Canada, and BWI districts, from an instrumentation school presented at the company's Research and Development Laboratory in Houston. The class covers all phases of logging techniques, and is presented periodically as a part of the Welex program of research, as well as part of its plan to keep all technical personnel informed of the newer logging procedures.



A permanent display and demonstration unit of the Murdock Tank & Manufacturing Company 50-barrel single shell meter and dump tank custody transfer system installed at the company's Tulsa plant, 3418 South Santa Fe. Viewers can see lease automatic custody transfer of oil to the simulated pipeline to show the process and controls. Visual means are provided to permit observation of internal flow of the process. A compact rack mounted control panel with fail-safe features, time delays and plug-in features is a part of the display.

7 days of island luxury

for as low as $26.80*

7 days and 6 nights at Galveston's finest resort hotels. Beautiful new guest rooms, superb seafood, swimming pool, nightly movies, shuffleboard and 30 miles of sand and surf await your pleasure. See your travel agent or write to Hotel Galvez.

*per person, 2 to a room, European plan. 4 days—3 nights, $13.95

THE BUCCANEER and GALVEZ HOTELS

SWIMMING POOL—AIR CONDITIONED—TV

AFFILIATED NATIONAL HOTELS

AIR CONDITIONED TELEVISION RADIOS

ALABAMA: Mobile—the Admiral Semmes; Birmingham—the Thomas Jefferson. WASHINGTON, D. C.—the Washington. INDIANA: Indianapolis—the Claypool. LOUISIANA: New Orleans—the Jung and the De Soto. NEBRASKA: Omaha—the Paxton. NEW MEXICO: Clovis—the Clovis. SOUTH CAROLINA: Columbia—the Wade Hampton.

TEXAS: Austin — the Stephen F. Austin; Brownwood — the Brownwood; Dallas—the Baker and the Travis; El Paso—the Cortez; Galveston — the Buccaneer, Galvez, Seahorse, Jean Lafitte and Coronado Court; Laredo — the Plaza; Lubbock — the Lubbock; Marlin — the Falls; San Angelo—the Cactus; San Antonio—the Menger and the Angeles Courts. VIRGINIA: Mountain Lake — the Mountain Lake; Norfolk—the Monticello.

OFFICES:

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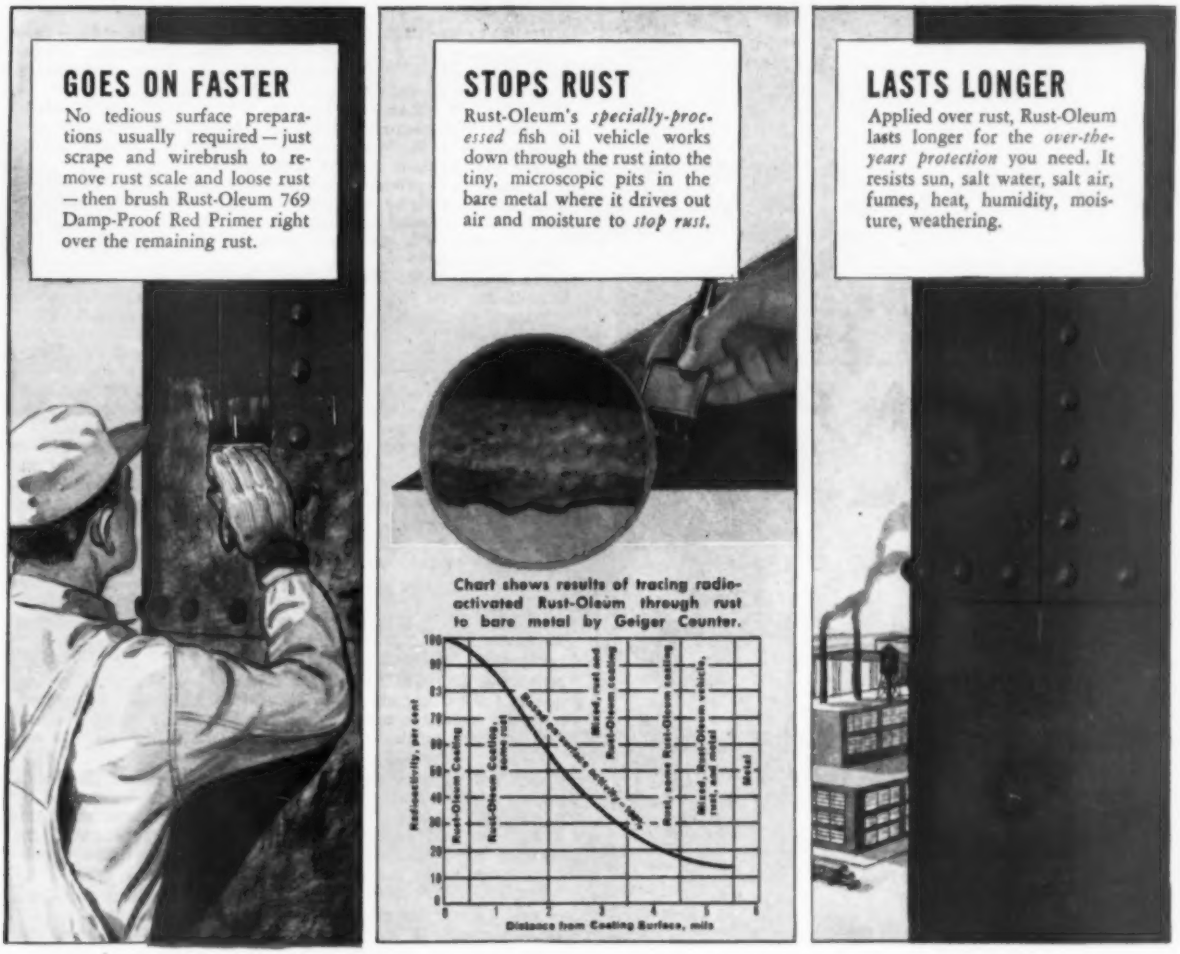
Free Inter Hotel Teletype Reservation Service

Three Rust-Oleum DIFFERENCES that save you time, money and metal!


GOES ON FASTER
No tedious surface preparations usually required — just scrape and wirebrush to remove rust scale and loose rust — then brush Rust-Oleum 769 Damp-Proof Red Primer right over the remaining rust.
STOPS RUST
Rust-Oleum's *specially-processed* fish oil vehicle works down through the rust into the tiny, microscopic pits in the bare metal where it drives out air and moisture to *stop rust.*
Chart shows results of tracing radio-activated Rust-Oleum through rust to bare metal by Geiger Counter.
Radioactivity, per cent
Distance from Coating Surface, mils
Rust-Oleum Coating
Rust-Oleum Coating, some rust
Mixed, rust and Rust-Oleum coating
Rust, some Rust-Oleum coating
Mixed, Rust-Oleum vehicle, rust, and metal
Metal
LASTS LONGER
Applied over rust, Rust-Oleum lasts longer for the *over-the-years protection* you need. It resists sun, salt water, salt air, fumes, heat, humidity, moisture, weathering.

These are just a few of many important *differences* that separate Rust-Oleum from ordinary coatings. When you consider that Rust-Oleum covers approximately *30% more area,* depending upon surface condition and porosity . . . and the fact that Rust-Oleum finish coatings, with the same fish oil vehicle, are available in nearly every color for *double protection* . . . it's just good, common sense to use Rust-Oleum. Prompt delivery from Industrial Distributor stocks. Write for illustrated literature with color charts.

RUST-OLEUM®

STOPS RUST!®

Rust-Oleum is distinctive as your own fingerprint. Accept no substitute.

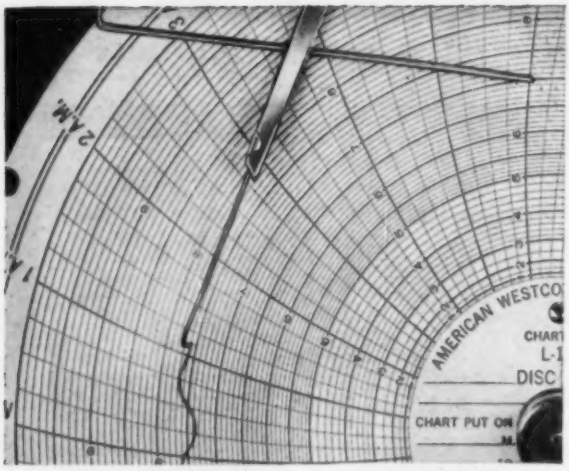
ATTACH TO YOUR LETTERHEAD — MAIL TODAY

Rust-Oleum Corporation

2639 Oakton Street • Evanston, Illinois

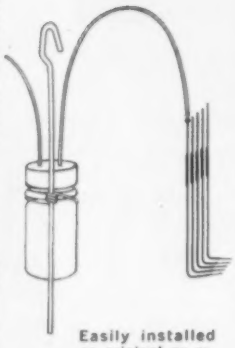
- ☐ Complete literature with color charts.
- ☐ 30-page report on Rust-Oleum penetration.
- ☐ Nearest source of supply.

Rust-Oleum and Stops Rust are brand names and registered trademarks of the Rust-Oleum Corporation.



CANNON PENS

assure legible charts ...eliminate inking problems



Easily installed as original or replacement equipment in all standard recording instruments. Available in five sizes and angles—special pens upon request.

Cannon controlled-flow capillary meter pens provide exceptional dependability and long life with minimum maintenance. Easy to install, these precision pens produce accurate chart records of maximum legibility and continuously record up to a full year without refilling reservoir.

- **Ends Unrecorded Intervals.** Unaffected by pulsating flows, chart speeds, rapid pen movement.
- **Sealed Ink Supply.** Prevents clogging from atmospheric contamination.
- **Two-Way Ink Flow.** Stainless steel writing point is positioned above ink level in reservoir and ink flows in either direction by capillary action—eliminates smearing, blurring.
- **Special Pens.** Designed and produced to customer specifications where special inking problems make standard pens impractical.

Write today for information

AMERICAN METER COMPANY

INCORPORATED ESTABLISHED 1836

GENERAL SALES OFFICE: Philadelphia 16, Penna. • Albany • Alhambra • Atlanta • Baltimore • Birmingham • Boston • Chicago • Dallas • Denver • Erie • Houston • Kansas City • Los Angeles • Minneapolis • New York • Omaha • Pittsburgh • San Francisco • Seattle • Tulsa • Wynnewood. IN CANADA: Canadian Meter Company, Ltd., Milton, Ontario • Calgary • Edmonton • Regina

SUPPLIERS TO THE GAS INDUSTRY for Ironcase, Tinned Steelcase, Aluminumcase and Welded Steelcase Meters • American-Westcott Orifice Meters Instruments • Reliance Regulators • Apparatus • Valves

Trade Parade

ALCO PRODUCTS, INC., announced a reorganization of its marketing research and advertising and sales promotion operations in line with a move to bolster marketing efforts.

Arthur A. Batts Jr., former director of advertising and marketing research, has been promoted to director of commercial research and A. Robert Jaeckel to director of advertising and sales promotion.

JOHNS-MANVILLE opened the first continuous-process asbestos-cement pipe plant in the United States at Denison, Texas, in June. The new plant, operated by electronic push-button controls, is an almost completely automatic factory.

ITS UTILITY TRACTOR business is being expanded by Allis-Chalmers Manufacturing Company, Milwaukee, with the appointment of J. D. Morris as sales manager of the new utility tractor and equipment sales department.

In addition to products manufactured and sold by Allis-Chalmers, the company has set up a program of engineering clearance under which selected applicable companion products of outside manufacturers will provide a complete line of equipment for utility applications.

ESTABLISHMENT OF oil field service operations in Bolivia is announced by Perforating Guns Atlas Corporation, Houston subsidiary of Chemetron Corporation (formerly National Cylinder Gas Company). Paul C. Charrin, PGAC president, said the new overseas activity is being started under contract with Yacimientos Petroliferes Fiscales Bolivianos, Bolivian government oil company. Headquarters will be at Camiri and the company will serve the Bolivian oil fields which extend approximately 150 miles along the eastern side of the Andes mountains.

OKLAHOMA CITY has been added to the growing list of branch offices recently opened by Lufkin trailers, a division of the Lufkin Foundry and Machine Company, manufacturers of truck-trailers, oil field equipment and industrial gears. The Oklahoma City branch sales and service office brings their factory owned and operated branch offices to six opened within 15 months.

CONTINENTAL-EMSCO Company announced the opening of a new pump shop in Luling, Texas. The Continental-Emsco D+B Pump Shop will be managed by B. R. Greive, former store manager for the oil field supply and manufacturing company at McAllen, Texas. L. E. Fullingnam is the D+B specialist and the pump shop foreman is W. L. McWhorter.

JONES & LAUGHLIN SUPPLY Division of Tulsa and Continental Tank Company of Oklahoma City announced an agreement for exclusive supply company distribution of Continental tanks throughout the oil fields of the United States, Canada and overseas.

EXPANSION of the new Henry, Illinois, General Chemicals plant of B. F. Goodrich Chemical Company is announced by Company President John R. Hoover. The announcement coincides with the beginning of manufacturing operations at the recently completed plant to produce specialty organic chemicals for use in the petroleum, rubber, plastics, etc.

NEW EXECUTIVE vice president of Dresser Industries, Inc., is J. P. Gasser. He has long been associated with the Seaboard Oil Company, of which he was executive vice president and member of the executive committee from 1953 to this year.

AN EXPANSION of the chemical products marketing group of National Carbon Company, Division of Union Carbide Corporation, has been announced by W. W. Palmquist, manager. To extend customer service and improve the efficiency of the national sales organization, two field sales divisions have been established with headquarters in New York and Chicago.

E. S. Malkin, formerly chemical products field salesman in New York, has been named eastern division manager. J. F. Brauning, formerly chemical products field salesman in Chicago, has been appointed western division manager.

TWO RECORDS were set here by Lukens Steel Company which, within the space of two weeks, made and shipped the heaviest pressed heads and the heaviest spun heads ever formed.

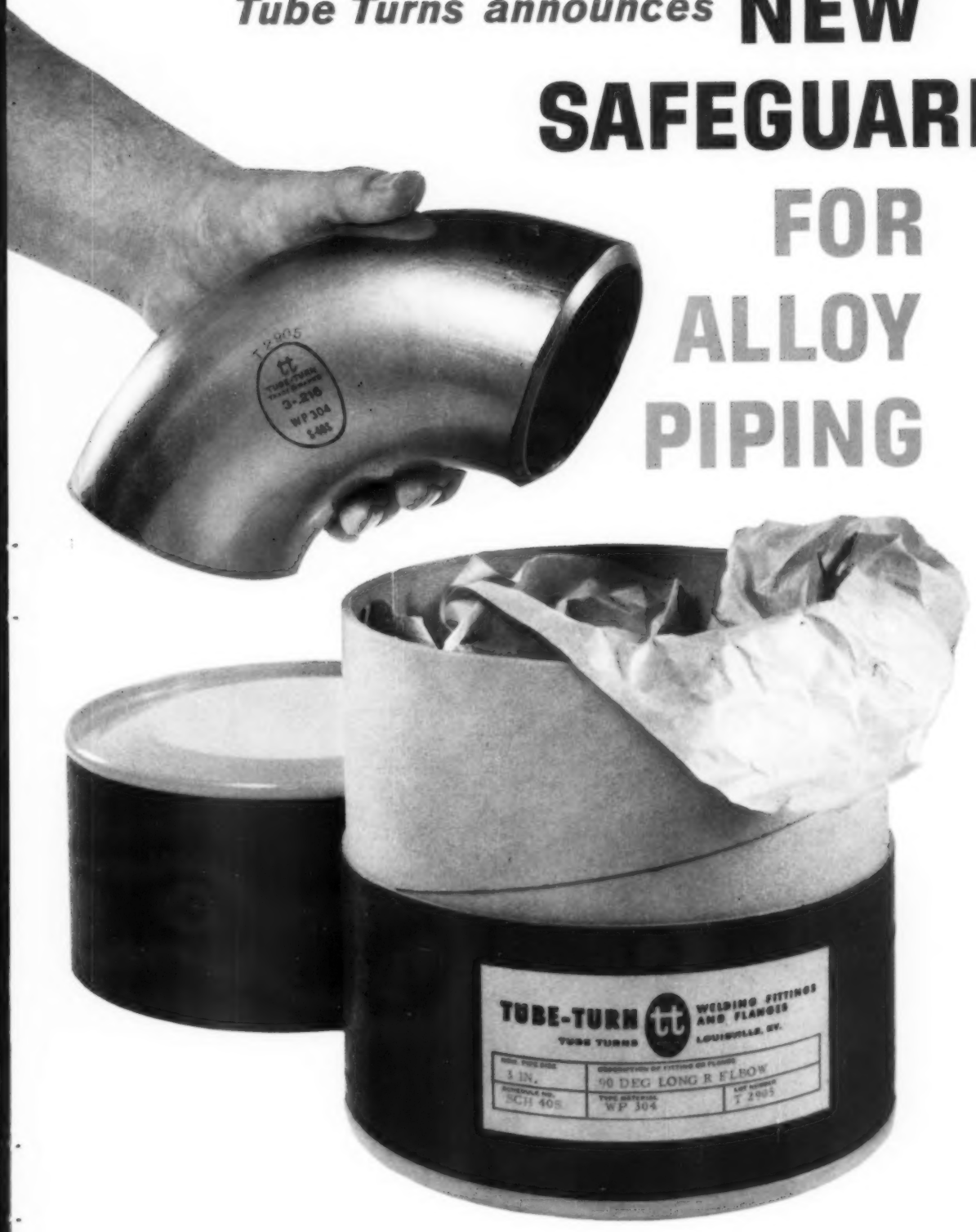
Two heads, each weighing approximately 22,540 lb, were spun for use in petroleum refining equipment being made by A. O. Smith Corporation. Four heads, each weighing approximately 16,340 lb, were pressed for use in power boilers being made by Combustion Engineering, Inc.

FAIRBANKS COMPANY, of Binghamton, New York, announced appointment of Henry H. Paris Distributor, Inc., Houston, as exclusive distributor in the Mid-Continent and Gulf Coast areas for the company's complete line of bronze and iron valves. Fairbanks Valves are sold exclusively through the jobbing trade and used extensively in the oil industry, as well as in a broad range of other industrial services.

INTEGRATION OF Service Bulk Mud Company of Liberty, Texas, and its personnel into Baroid Division National Lead Company has been announced. V. R. Burch, organizer and previous owner of Service Bulk Mud Company, joins Baroid Division with over 29 years of experience in mud distribution in the Texas Gulf Coast area.

Tube Turns announces **NEW**

SAFEGUARD FOR ALLOY PIPING



For details, turn the page . . .

NOW...individual packaging protects each TUBE-TURN® Alloy Welding Fitting and Flange

AVAILABLE IN...

STAINLESS STEELS	COPPER
ALUMINUM ALLOYS	SILICON BRONZE
NICKEL	RED BRASS
MONEL	ADMIRALTY METAL
INCONEL	TITANIUM
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...and other non-ferrous metals and alloys

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on TUBE-TURN Alloy Fittings and Flanges

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Please send me bulletins on these fittings and flanges:
☐ Alloys ☐ Stainless Steel ☐ Aluminum
Company Name _____
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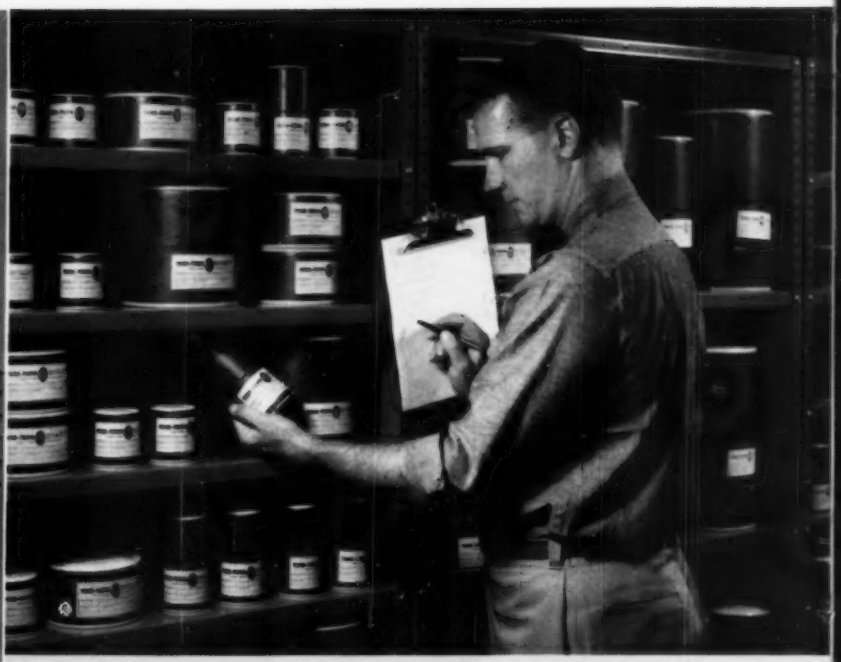


Your nearby Tube Turns' Distributor can supply your fitting needs in alloys and non-ferrous metals . . . as well as in carbon steel, wrought iron, carbon-moly and chrome-moly. This one source for all your requirements in welding fittings and flanges enables you to simplify purchasing and cut red tape.

Tube Turns is now safeguarding the top quality of its stainless steel, aluminum and other alloy products with individual packaging. All of these fittings in sizes through 12", and flanges through 8", are now wrapped in kraft paper and individually packaged in a rugged container, built to standards established by extensive testing. Hence, from point of rigid inspection to job site, *each* fitting is *protected* against damage.

Here is new *convenience*, too. Your fittings are easier to store. And each container is fully marked with description of fitting or flange, size, schedule, type material and production lot for positive, easy identification in the warehouse or on the job.

Here is another plus value you get when you specify TUBE-TURN* Alloy Fittings and Flanges, and buy them from your nearby Tube Turns' Distributor.

The trademarks "TUBE-TURN" and "tt" are applicable only to the quality products of Tube Turns.

*"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

TUBE TURNS

DIVISION OF CHEMETRON CORPORATION
Louisville 1, Kentucky

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Detroit • Atlanta • New Orleans • Houston • Midland • Dallas • Tulsa • Kansas City • Denver • Los Angeles • San Francisco • Seattle
IN CANADA: Tube Turns of Canada Limited, Ridgetown, Ontario. DISTRICT OFFICES: Toronto, Ontario • Edmonton, Alberta • Montreal, Quebec • Vancouver, British Columbia

CHEMETRON

Trade Parade

AN ACROSS-THE-BOARD DISCOUNT of 15 percent on all Hughes rock bits, distributed for use in the United States and Canada, was announced in Houston by M. E. Montrose, vice president-sales, Hughes Tool Company.

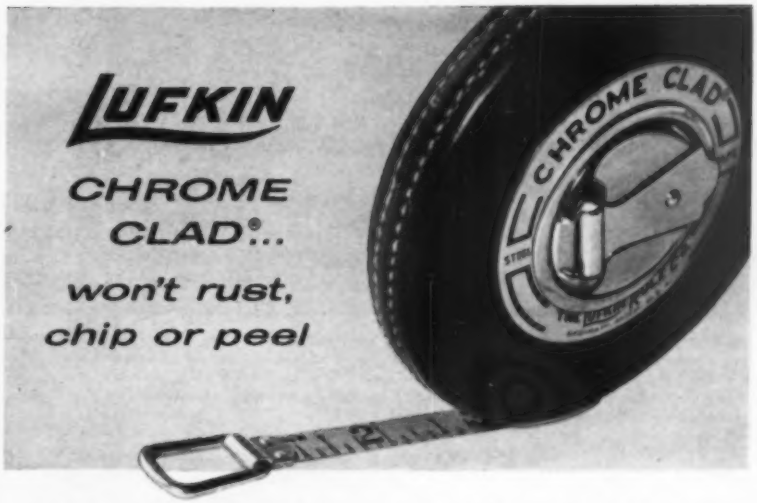
In making the announcement, Montrose said that the reduction in the price of Hughes rock bits was made to aid the drilling industry hard hit by the serious slowing down of drilling in the United States and Canada, and to help stimulate the over-all economy grown dependent in a large degree upon a healthy oil industry.

JOY MANUFACTURING Company announced its Oil Field Drill Division at Dallas, Texas, is being consolidated with two of the company's other divisions.

The manufacturing operations and the marketing of rotary blast hole, and water well drill products, are being consolidated with Joy's Mining and Construction Division, Michigan City, Indiana. Oil field products will be handled through the company's Baash-Ross Division, headquartered in Houston.

TEXAS INSTRUMENTS Incorporated dedicated its new 310,000 sq ft plant of revolutionary design for the manufacture of transistors and other semiconductor devices on a 300-acre site on June 23, by using the signal from the American satellite Vanguard to cut the traditional ribbon.

TI-made transistors are playing an important role in the instrumentation of th orbitting satellite. Dr. James R. Killian chairman of the President's Advisory Committee on Science, made the dedicatory address.



There's no paint on Lufkin Chrome Clad Anchor Tape lines.

The bold, black markings are bonded to the basic metal . . . protected with several electroplatings that give extra strength to the line. The final metal coat is Lufkin's exclusive Chrome Clad finish. Glare free, smooth, rust resistant . . . the most durable tape line you can buy.

Anchor lines are replaceable in the genuine-leather, hand-stitched case. Available with markings in feet, 10ths and 100ths.

THE LUFKIN RULE COMPANY
TAPES • RULES • PRECISION TOOLS
SAGINAW, MICH. • NEW YORK CITY • BARRIE, ONT.

HOTEL MENGER SAN ANTONIO

Yours for a Latin holiday . . . the colorful traditions of Old Mexico mingled with the ease and luxury of 'gringo' comfort. Visit Texas' most romantic city . . . and choose the Menger, by the Alamo . . . San Antonio's only resort hotel. Outstanding food and guest accommodations, private parking lot with lobby entrance.

AFFILIATED NATIONAL HOTELS
AIR CONDITIONED
TELEVISION
RADIOS

ALABAMA: Mobile—the Admiral Semmes; **Birmingham**—the Thomas Jefferson. **WASHINGTON, D. C.**—the Washington. **INDIANA: Indianapolis**—the Claypool. **LOUISIANA: New Orleans**—the Jung and the De Soto. **NEBRASKA: Omaha**—the Paxton. **NEW MEXICO: Clovis**—the Clovis. **SOUTH CAROLINA: Columbia**—the Wade Hampton.

TEXAS: Austin — the Stephen F. Austin; **Brownwood** — the Brownwood; **Dallas**—the Baker and the Travis; **El Paso**—the Cortez; **Galveston** — the Buccaneer, Galvez, Seahorse, Jean Lafitte and Coronado Court; **Laredo** — the Plaza; **Lubbock** — the Lubbock; **Marlin** — the Falls; **San Angelo**—the Cactus; **San Antonio**—the Menger and the Angeles Courts. **VIRGINIA: Mountain Lake** — the Mountain Lake; **Norfolk**—the Monticello.

OFFICES:

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Chicago	MOhawk 4-5100
Mexico City	46-98-92
Washington	EXecutive 3-6481
Galveston	SOuthfield 5-8536

Free Inter Hotel Teletype Reservation Service

Appleton Opens Pacific Coast Factory in the central manufacturing district of Los Angeles. Utah, Nevada and Western Texas as well as the Pacific Coast states will be served on an overnight delivery basis from Los Angeles. The new "Pacific Division" facilities are completely modern in every respect. William A. Mundy has been named general manager of the division and Eugene L. Cherry heads the manufacturing phase.

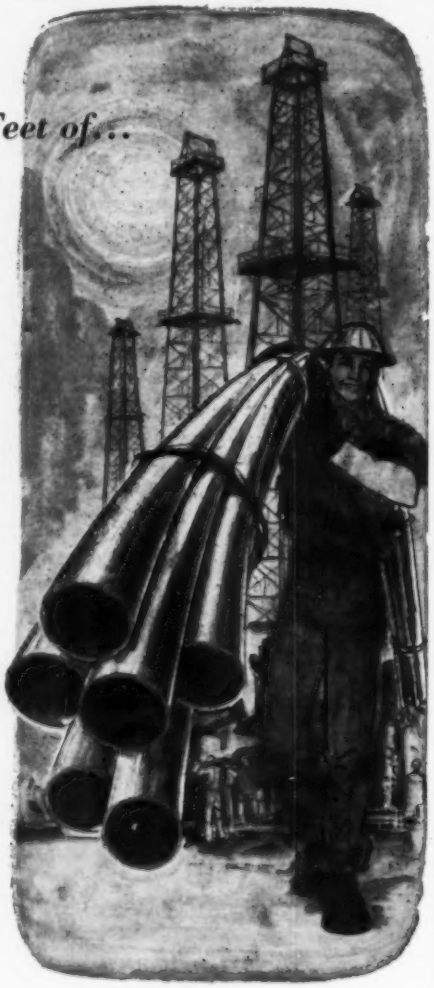
Over One Million Feet of...

KRALOY

HIGH-IMPACT

PVC PIPE

in oil-country use today



This proves that there is no substitute for Kraloy experience.

KRALOY is the most experienced manufacturer of PVC plastic pipe for the petroleum industry. The first polyvinyl chloride lead line installed in this country—at Great Bend, Kansas—was Kraloy Pipe. Kraloy High-Impact PVC today is preferred by production men for maintenance-free service in lead lines and disposal systems. Kraloy customers use Kraloy High-Impact PVC pipe for lead lines, gas lines, and salt water lines because Kraloy normally eliminates (1) sulphur corrosion due to sour crude, (2) paraffin buildup, (3) corrosion and scale, (4) trouble from soil electrolysis.

YOU Benefit From KRALOY'S Quality Control

To insure quality control, random samples of Kraloy Plastic Pipe are tested daily in Kraloy's own laboratory for burst pressure, impact resistance, and tensile strength under standard ASTM specifications.

Kraloy Pipe is Sold Only Through Qualified Supply Stores

Warehouse stocks and sales representatives:

Kraloy Export Office, 30 Rockefeller Plaza
N. Y. 20, N. Y.

John Piersol, 13913 Hillcrest Rd.
DALLAS 30, TEXAS

The Mack Company, 2005 Hackney St.
HOUSTON 23, TEXAS

J. W. Massey, Jr., P. O. Box 2224
MIDLAND, TEXAS

Ross Howell, 209 E. Scott St.
WICHITA FALLS, TEXAS

The Becker Sales Company, P. O. Box 2262
TULSA, OKLAHOMA

The Becker Sales Company, 3013 S. High St.
OKLAHOMA CITY, OKLAHOMA

Robinson Oil Field Specialties, 616 Main St.
GREAT BEND, KANSAS

For Detailed Information, Write Dept. PE

KRALOY *plastic pipe co., inc.*

4720 East Washington Boulevard, Los Angeles, Calif.

Subsidiary of the Seamless Rubber Co., a Rexall Drug Co. Subsidiary

Plans New Pipe Mill

National Tube Division, United States Steel Corporation, announced that it would construct a new continuous buttweld pipe mill at its Lorain, Ohio, works. John E. Goble, president of National Tube, said that construction of this major facility is expected in the next two to three years.

The new buttweld mill will be designed for production of finished pipe in a size range of 1½ inches to 4 inches and will be the most modern continuous buttweld mill ever built. The new unit will be housed in a new building and includes finishing equipment and stocking and handling facilities. Capacity of the new mill will be 237,000 tons of finished pipe per year.

CONSTRUCTION of a new district station and expansion of facilities and services at another district of The Western Company were announced by H. E. Chiles, Jr., Western president. The new installation is under construction at Kermit, Texas. The service company will offer its complete line of well services — logging, perforating, fracturing and acidizing — for that area. Operation from the station is slated to begin in mid-June.

Expansion of facilities at Hobart, Oklahoma, will include logging and perforating in addition to the already established acidizing service was also announced. The station will also expand its acidizing facilities and equipment.

INTEREST ENCOUNTERED in its Model 104 Nuclear Magnetic (NMR) Analyzer, and increasing areas of application of this instrument since its recent introduction to the market, led Schlumberger Well Surveying Corporation, Ridgefield Instrumentation Division, to set up a complete marketing organization for Model 104, it is announced by A. Russel Aikman, Schlumberger Marketing Director.

Charles Morgan, assisting Mr. Aikman as Sales Manager, will be in charge of this nationwide organization. The following companies will be taking part in the distribution: J. J. Maguire Company, Washington, D.C., and South Atlantic States; Atlantex, New England; Harshaw Scientific Division of Harshaw Chemical, Central States; Van Waters & Rogers, far West; Pitchford Scientific Instruments, Western Pennsylvania.

A. T. GREEN MACHINERY Co., Route 8, Pittsburgh, Pennsylvania, was appointed distributor for the complete line of Cleveland trenchers, sidecranes, backfillers and tampers. The Green organization will handle sales, parts and service of Cleveland equipment in western Pennsylvania.

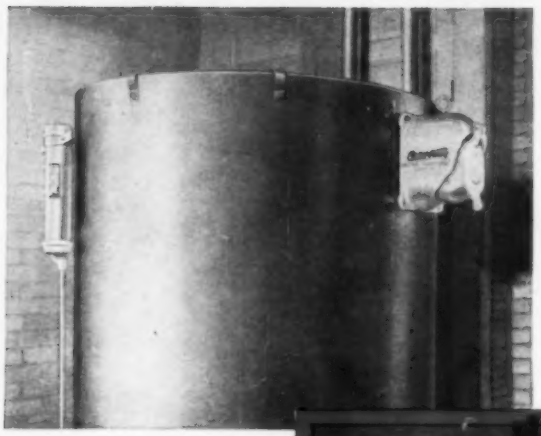
A NEW SALES AND SERVICE location in San Antonio at 8602 North New Braunfels Avenue was opened by Waukesha Sales & Service. This brings to 13 the total number of Waukesha offices. At each of these centers are offered complete stocks of Waukesha and Climax engine parts, in addition to complete repair facilities.

Branch manager in San Antonio is Joe Downs and assistant branch manager is Charlie Hall.

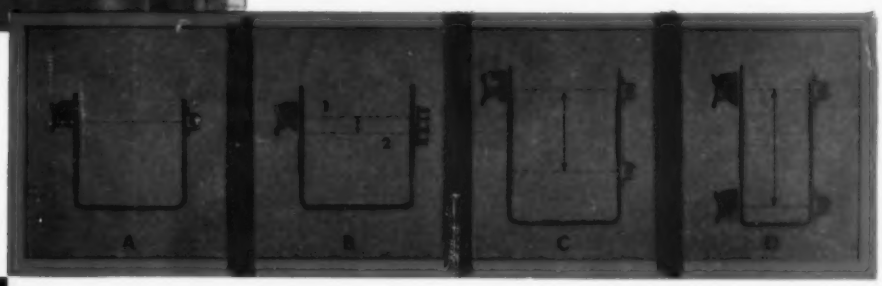
POLYKEN SALES Division of The Kendall Company recently enfranchised Patterson Supply Company, 4003 Walnut, Denver, Colorado, to carry its protective tape coatings line. This addition will provide increased service to the Southwest and Rocky Mountain Areas.

AccuRay... TANK OR BIN LEVEL SYSTEMS

A Level Detector-Controller System Designed to your Requirements



Adaptable to four methods of operation, AccuRay's Detector-Controller offers outstanding advantages over float-level type control systems. It is easily installed and maintained and is priced from only $465.00. The Detector-Controller utilizes two units—a radiation source housing, which provides more than adequate shielding, and a detector. Both units are mounted externally . . . thus are free from fouling by process materials. Accuracies can be maintained to ± ⅛" as a high or low level alarm. The source housing can be pivoted to provide radiation shielding during work inside the tank. Design of the instrument is in accordance with accepted standards for both explosion-proof and weatherproof operations.



another AccuRay advancement for process control

AccuRay® is a registered trademark of Industrial Nucleonics Corporation

A High or Low Level Control . . . The detector is mounted diametrically opposite the radiation source. When the material moves above the level of the detector, the radiation is cut off, causing the output relay to change position. When the material drops below the level, the output relay is thrown to its opposite position. **B** Narrow Band Control . . . The detector is mounted vertically along the tank, resulting in narrow band control. When the material moves above position (1), a signal is provided from the output relay. The opposite signal is provided when the material drops below level (2). **C** Wide Band Control . . . A single source unit is teamed with two detector elements. The material can be controlled within the distance separating the high and low level detectors. The signal can also be used to provide a combination high-low level alarm system. **D** Extra-Wide Band Control . . . Two source units are teamed with two detectors in cases where the vertical separation desired is large relative to the tank diameter. This system can also provide a high or low level alarm.

Also available is the AccuRay continuous tank or bin level measurement system . . . Continuous indication of the level of material is read directly from an indicator or recorder. The system may also be instrumented to provide automatic control of level.

Please send complete details on AccuRay Tank or Bin Level Detector-Controllers.

Name _____ Title _____

Company _____

Street _____

City _____ Zone ____ State _____

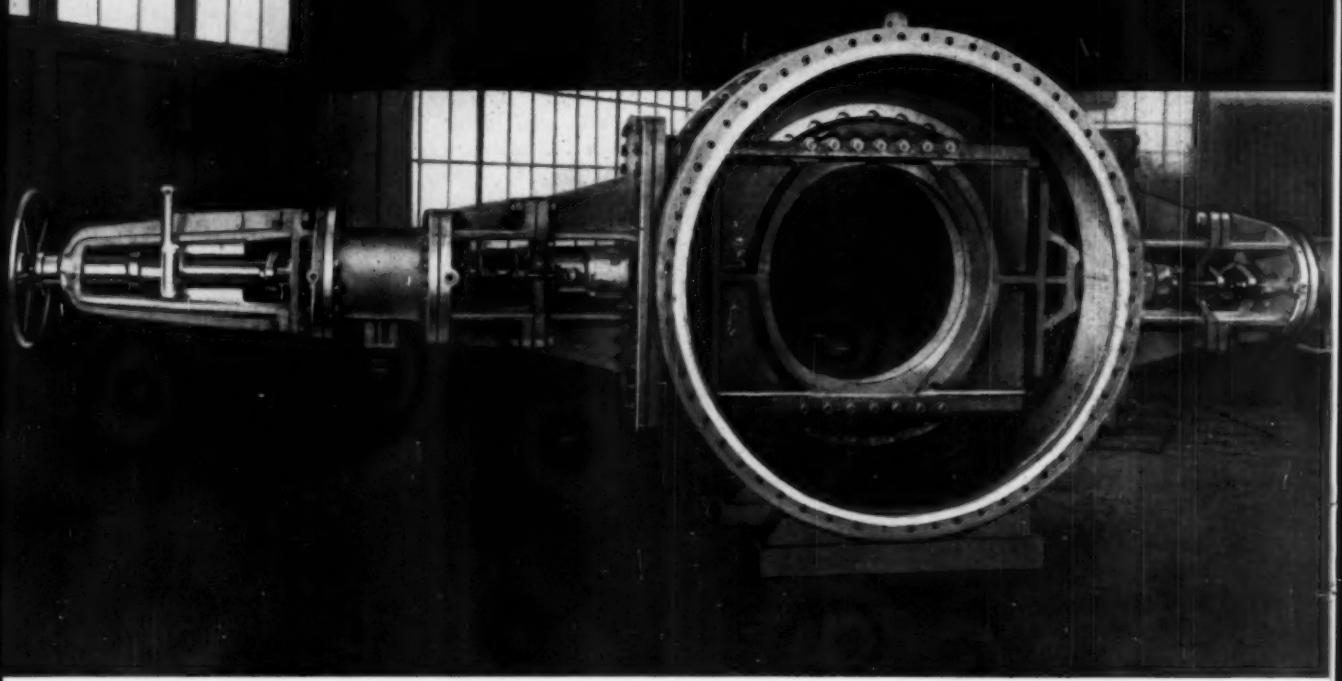
Application _____

Industrial Nucleonics
CORPORATION
1165 Chesapeake Ave., Columbus 12, Ohio

The WORLD'S LARGEST Manufacturer of Nucleonic Industrial Process Control Systems

CHAPMAN

for the new plant of



Cylinder operated single disc slide valve on Chapman's assembly floor.

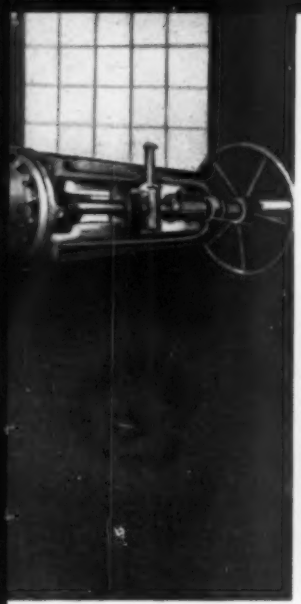
Ready for Shipment . . .

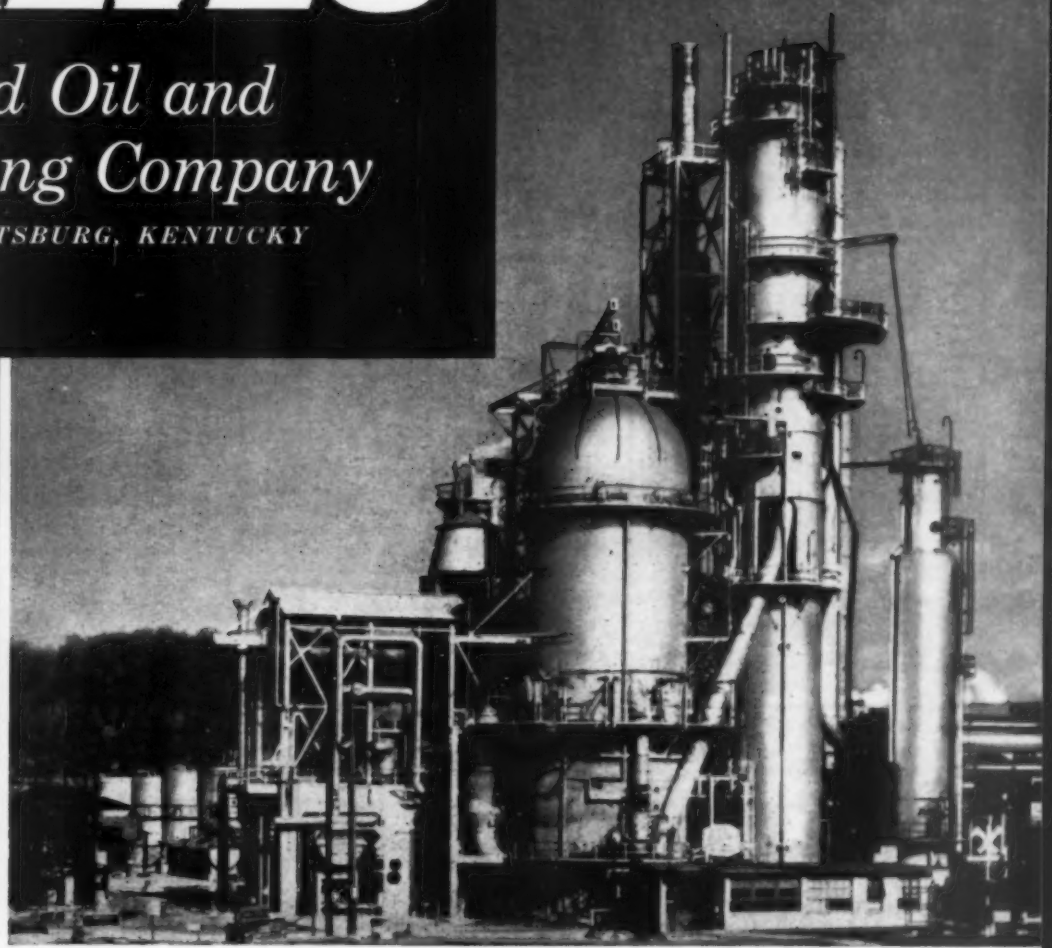
Briefly, here's the story. When Ashland Oil and Refining Company needed valves for their new fluid catalytic unit and crude fracionation facilities at Catlettsburg, Kentucky, it wasn't a "stock room" proposition. It was strictly an engineering problem — a matter of intelligent engineering in adapting materials and designs to the job to be accomplished.

VALVES

Ashland Oil and Refining Company

CATLETTSBURG, KENTUCKY





New crude unit and existing facilities at Ashland's largest refinery at Catlettsburg, Kentucky.

Ready for Operation . . .

Working with Universal Oil Products, who designed the Ashland unit, Chapman recommended, designed and built the slide and stack valves for this job. Four of these very special control valves were installed — three of them cylinder operated single disc slide valves with auxiliary geared heads, and one a cylinder operated double disc stack valve with auxiliary geared hand wheel.

Built by Procon, and built without interruption of adjacent facilities, Ashland's new Kentucky unit has a capacity of 20,000 barrels per stream day.

Regardless of your requirements it always pays to talk with Chapman and find out more about our engineering, designing, manufacturing and testing advantages. Write, and one of our engineers will give you a full consultation with no obligation to you.

The **CHAPMAN** *Valve Manufacturing Company*

INDIAN ORCHARD, MASSACHUSETTS

For over 75 years Chapman has been designing, developing and building valves to meet the usual and special requirements of industry in all parts of the world

PROTECT & SEAL THREADED FITTINGS

Apply **LED-PLATE**
Sealing & Anti-Seize Compound

Recommended for HYDRAULIC FITTINGS
will not plug orifices

FAST ASSEMBLY
No cross threads
Tight with less torque
Lead is a thread tube.
A REAL PIPE SEALER
Pressure held 20,000 psi up Liquid or Gas
U.L. approved for butane, propane, gasoline, petroleum.
Use for: Hydraulic fluids, steam, ammonia, etc.
NO HEAT FREEZE
Temperature range—100° to 2987° F.
NO CORROSION WELD
Stops rusting, acid-etch and corrosion.
NO GALLING OR SEIZING
Recommended for aluminum, stainless, titanium, plastic, steel, brass, etc.
EASY DISASSEMBLY ANYTIME
Better than new threads.

— for
STUDS, BOLTS, GASKETS
AIRCRAFT PLUMBING
AUTOS MARINE
OIL WELLS PIPING

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Stocked by Supply and Hardware Stores
Ask for FREE SAMPLE

ARMITE LABORATORIES
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new triple ignitors
Original Equipment In These Gas Engines
CLARK
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WORTHINGTON
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To get better service from your engines—regardless of make—send for FREE Pocket Catalog and Application Chart that specifies the RIGHT plug for ALL your engines. We'll also send you Field Reports which prove STITT New Triple Ignitors give better performance because they hold their gap setting longer.

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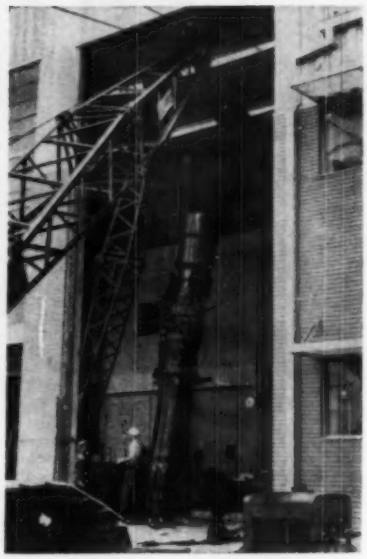
STITT MAKES HEAVY DUTY INDUSTRIAL SPARK PLUGS



FOR 30,000-FOOT WELLS. Two huge cranes work together to lower a 72,000 lb pressure vessel into position in the new high-pressure laboratory of Schlumberger Well Surveying Corporation. The vessel has a working pressure of 30,000 psi at 450 F, equivalent to hydrostatic pressures to be encountered in wells drilled well below 30,000 ft with normal drilling muds. The new laboratory, intended chiefly for research, was made necessary, say Schlumberger engineers, by the rapid strides made by the oil industry toward deeper drilling.

CONTINENTAL-EMSCO Company recently opened a new supply store in Venice, Louisiana. Located to serve the Delta area and many of the offshore rigs, the store is managed by James D. Hunter.

ACF INDUSTRIES moved into its executive offices at 750 Third Avenue, New York, after 32 years in the Hudson Terminal Building at 30 Church Street. Also involved in the move are the home offices of three of ACF's operating divisions — Advanced Products, American Car and Foundry and Shippers' Car Line.

WRIGHT AIR Development Center has awarded Consolidated Electrodynamics Corporation a $99,000 research and development contract for a mass spectrometer instrumentation system that will be used in materials research and analysis.

TERMINATION by mutual agreement of a 50-year association with Turbine Equipment Company, New York, and Turbine Equipment Company of New England as sales representatives, was announced by the De Laval Steam Turbine Company, Trenton, N.J.

De Laval established company sales offices on June 1, 1958 in New York, and about July 1, 1958 in Boston, to service all areas handled by their former sales representatives.

PELICAN MACHINERY Company, 7300 Washington Avenue, New Orleans, Louisiana, has been appointed by Koehring Division, Milwaukee, Wisconsin, and Parsons Company, Newton, Iowa, as their sales and service representative. Territory assigned to the new distributor by the two Koehring affiliates includes that portion of south Louisiana.

DESIGNED, TESTED AND PROVEN IN THE OIL FIELDS

Unexcelled . . . for **Outdoor Use**

- DRIP PROOF
- VERMIN PROOF
- MOISTURE PROOF
- CORROSION RESISTANT
- FORCED AIR COOLED

All these features of Fieldmaster Ball Bearing Motors have been designed to overcome the rugged conditions of Oil Field requirements.

FIELDMASTER

CHECK THESE OUTSTANDING ADVANTAGES.

Heavy Cast base for alignment, stability, heavy duty, double-shielded, prelubricated bearings, reduces lubrication worries, high grade silicon steel in the magnetic circuit reduces iron losses . . . Wide variety of windings provides triple ratings, dual voltages . . . high torque licks heavy starting problems. High slip is available to take care of reciprocating load requirements encountered in pumping.

Write For Descriptive Literature.

BETHLEHEM SUPPLY CO. TULSA, OKLAHOMA
Manufactured by VALLEY ELECTRIC CORPORATION, St. Louis, 8, Mo.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Laugh with Barney

It's hard to believe that America was founded to avoid taxation.

* * *

Tranquilizer retail sales will be about $175 million this year. Peace be with you!

* * *

"How did you spend this hot week-end?"
"Fishing through the ice."
"Fishing through the ice? For what?"
"Olives."

* * *

Salesgirl, showing lingerie to a man: "This is the only place you can touch these for anywhere near the price."

* * *

The best way to smother an argument is to keep your mouth shut!

* * *

"He is not as big a fool as he used to be."
"Is he getting wiser?"
"No, thinner."

* * *

Barney is going to write a drinking song if he can ever get past the first two bars.

* * *

"Don't just do something. Stand there!"

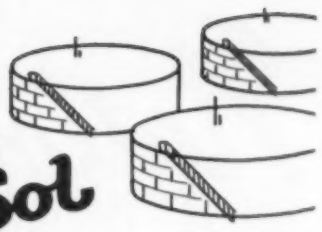
* * *

Papa Bull asked Junior Bull if, when he grew up, he wanted to be a bull in a China closet or a bull on Wall Street.
"Neither," replied Junior. "I'd rather stay here in the pasture for heifer, and heifer, and heifer."

* * *

If you don't think these are funny, send us your stories. Barney, Box 1589, Dallas 21, Texas.

RECLAIM TANK BOTTOMS with BrakeSol



the most effective chemical for treating PARAFFIN

The money you make on reclaimed tank bottoms by using BRAKESOL will be substantially more than the cost of treating . . . including chemical and labor. Safe for use in production, pipeline and refinery equipment . . . Contains no chlorides, sulphides or other halides.
BRAKESOL Treating Engineers have the experience and know-how to do a successful job. Contact them now!

Treating Engineers Available at These Locations

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OR CALL YOUR SUPPLY STORE

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EXPORT DISTRIBUTOR: THE NATIONAL SUPPLY CO., EXPORT DIVISION

NO BATTERIES TO WORRY ABOUT!

INGERSOLL-RAND
Air STARTING MOTORS
give you trouble-free engine starts

RELIABLE—I-R Air Starting Motors are built for fast, sure engine starting—anywhere.

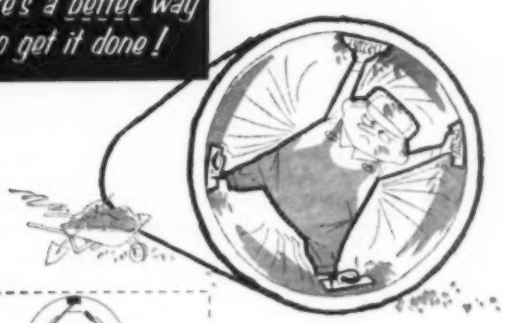
LOW COST—No batteries, generators or electrical parts to buy. Practically no maintenance expense.

COMPACT—I-R Air Starting Motors are lightweight, small but powerful. For all popular gasoline and diesel engine sizes. Easily installed.

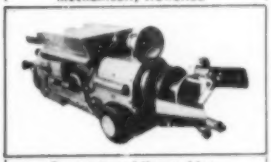
Ask your engine distributor to show you the I-R Air Starting Motor line. Or write for Bulletin 5094A. 18-512

INGERSOLL-RAND
11 Broadway, New York 4, N.Y.

there's a better way to get it done!



Centrifugally applied and mechanically trowelled



Compact, mobile machine moves through the line

Centriline Process applies smooth, continuous leak-proof lining to inside of 16" to 144" pipe lines "in place." Applicable to fresh or salt water, oil, gas or industrial waste lines. Eliminates interior corrosion and leakage. Restores full flow coefficients.

Write for full information TODAY!

Specializing in Pipe Protection Problems
• Tate and Centriline "In Place" Interior Cement Mortar Lining • "In Plant" and "Railhead" Centrifugal Spinning of Cement Mortar or Coal Tar Linings – Somastic® Exterior Coating • Pipe Wrapping • Reclamation: Removal of Old Wrapping, Straightening, Blasting, Beveling, Testing

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A Division of American Pipe and Construction Co.
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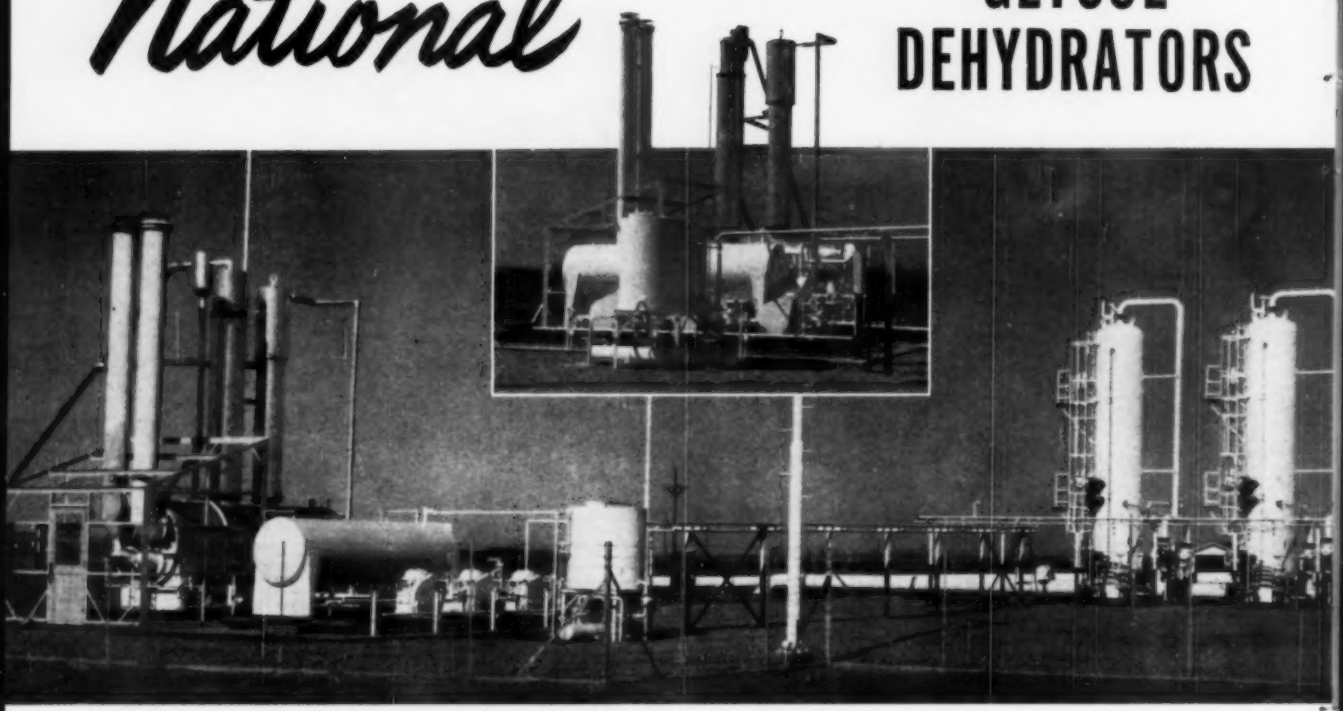
GLYCOL DEHYDRATORS



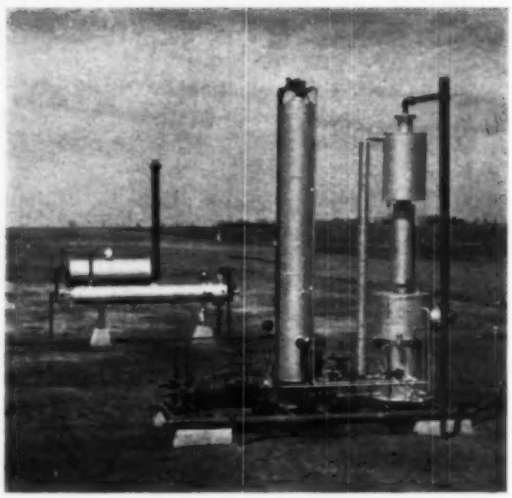
180,000,000 cu. ft./day capacity unit located in the southwestern United States. Installed downstream from a large compressor station.

Automatic Compact Glycol Dehydrators provide for absorption of water from the vapor phase into the dry glycol in the absorber tower. The wet saturated glycol is reconcentrated, followed by recirculation back to the absorber to begin its job all over again.

Glycol Dehydration provides the lowest initial installation cost over other systems and will dry gas to pipeline specifications for most operating conditions. Standard units are available in capacities from the small individual well type (2,000,000 cu. ft./day) to the large central installation (200,000,000 cu. ft./day). Alternate features include winterizing for extreme cold weather operation, housing, integral inlet scrubbers and electric driven pumps.

Designed and engineered to afford "packaging" of greatest per cent of the complete unit.

National can handle all of your gas-production problems — "from the wellhead to the consumer!" Contact your National Representative in your area.



One well unit with indirect heater and inlet MONOTUBE® separator.

WRITE FOR BULLETIN 504-A ON GLYCOL DEHYDRATORS.

It's a National®

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

the Petroleum Engineer
Exploration
Drilling
Producing

Good equipment

MAKES Higher Profit

WHEN OPERATED BY A GOOD CREW

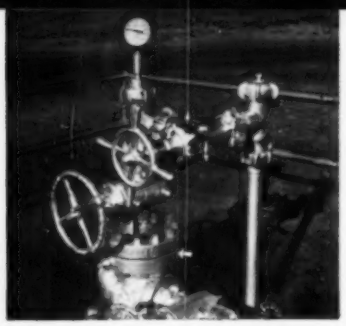
When competition is roughest it is more important than ever to have good equipment operated by good crews. You do a better job for customers and keep your units busy. This reflects in your bank book.

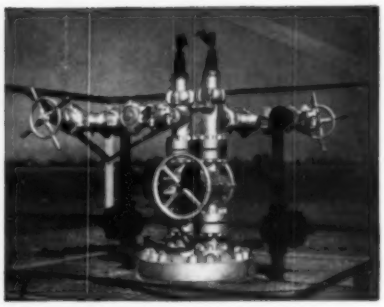
Franks well servicing and workover rigs are just such equipment.

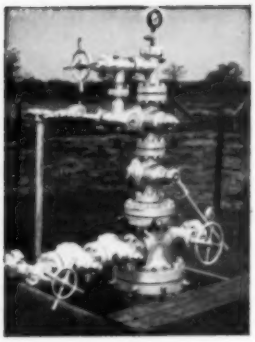
Rig-up is faster with a telescoping derrick that moves strung-up, raises hydraulically, is simple to level, and guys to the unit.

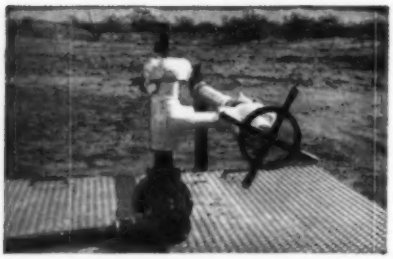
The air lift transfer provides speed in pulling, and stacking affords protection to rods and tubing. See a Franks representative or write for details on the various Rocket models 6,500 to 12,000 ft.

• WELL SERVICING AND DRILLING UNITS •
FRANKS
DIVISION OF
PAMPA, TEXAS
CABOT SHOPS, INC.









Nice thing about UNIBOLT Flow Manifolds . . .

you buy only what your well needs, and no more

Since well conditions and completion methods differ widely, no one Christmas tree flow control of the "fixed design" type can possibly serve all wells efficiently. Not so with UNIBOLT Flow Manifolds, the components of which may be readily arranged in any design to exactly fit well requirements.

These flexible Flow Manifolds, composed of standard UNIBOLT Tees, Crosses, Adjustable Wing Valves or Chokes, can be combined in a dozen different ways. Thus, you buy exactly what is needed for a given well.

And the entire manifold may be salvaged as a unit or in separate parts for later use in other manifolds.

From the lightest screwed manifold to the heaviest high-pressure assemblies and corrosion-resistant steel, UNIBOLT Flow Manifolds can be tailored to your needs. You save steel and, at the same time, you hold capital investment to a minimum.

THORNHILL CRAVER CO.
P. O. BOX 1184 HOUSTON, TEXAS

Of Things To Come . . . In Oil

LOOK FOR THE SONIC OIL WELL PUMP to make its appearance on the market in the very near future. Bugs have been worked out and commercial models are designed. Vibrations of the tubing in the sound range provide the lifting action. The idea was first tried in California some four years ago.

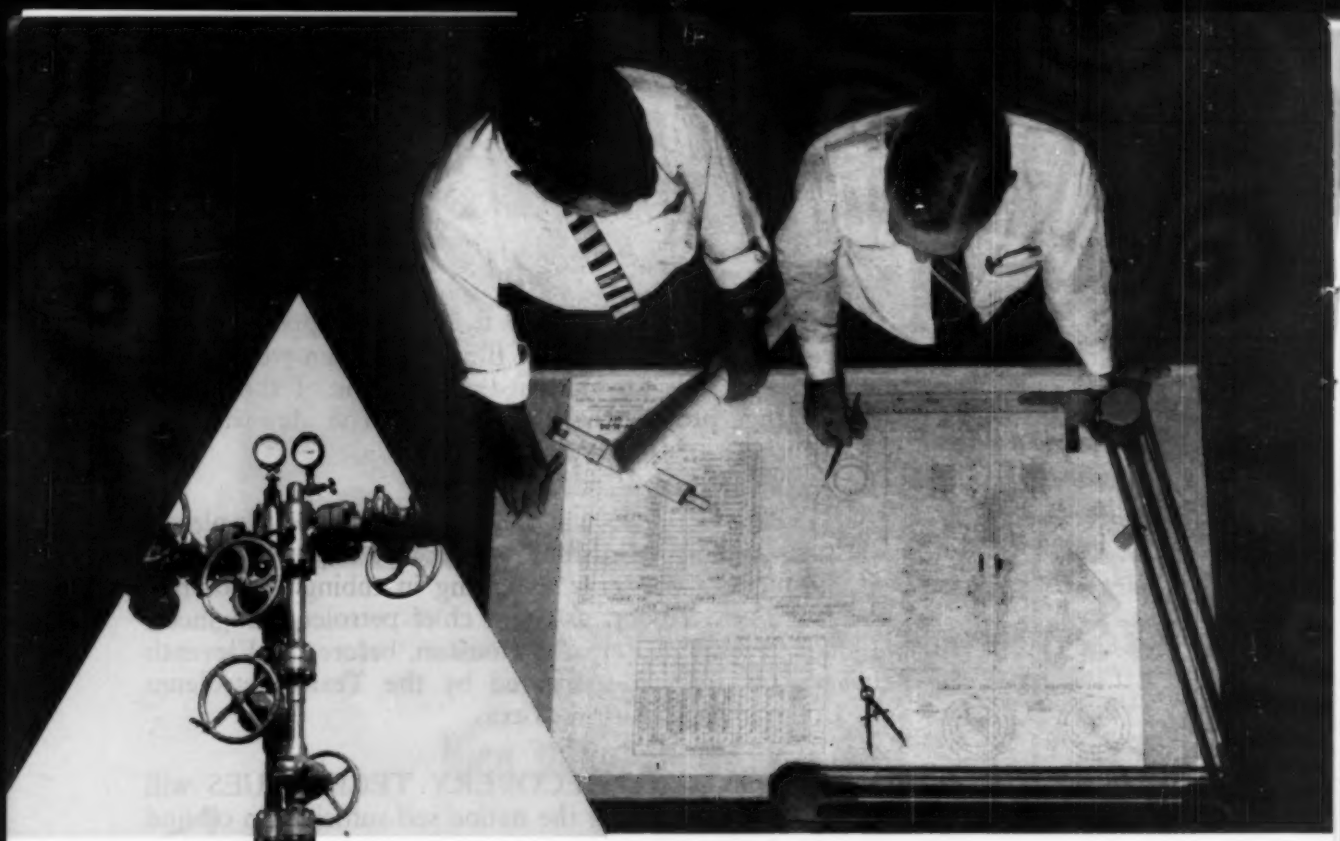
DRILLING RIG OF THE FUTURE will be highly mobile, completely automatic and capable of drilling to medium depths with one small bit. Drill pipe will serve as casing in tubingless completions, predicts T. A. Huber, assistant chief petroleum engineer, Humble Oil & Refining Company, Houston, before the Eleventh Oil Recovery Conference sponsored by the Texas Petroleum Research Committee at Austin, Texas.

FLUID INJECTION, SECONDARY RECOVERY TECHNIQUES will be dominant factor in keeping the nation self-sufficient in oil and are responsible for boosting present proved reserve estimates from 30 to 43 billion barrels. Improved secondary methods will be responsible for removing as much as 67 billion barrels from the present "unrecoverable" oil reserve totaling 208 billion barrels, reports Paul Torrey to the Interstate Oil Compact Commission.

ALASKA'S CURRENT LEASING BOOM won't turn into a drilling boom overnight — just because of newly-acquired statehood. Industry observers indicate they will tread lightly until firm regulatory and conservation practices are instituted. Alaska has already been admitted to IOCC. Biggest assist for oil industry there is in the form of two newly passed laws setting firm leasing rules on government lands — part of which offer "preferential leasing treatment" to pioneer companies who want to gamble on Alaska.

OILFIELD EQUIPMENT AND SUPPLY PRICES will hold the line till winter — despite changing outside factors (such as a steel price hike, etc.). Keen competition among suppliers and manufacturers will keep prices on an even par — regardless. However, don't expect prices to go down any more: Bit and mud prices are now stabilized and cement "price wars" are now at the limit, observers agree.

GERMAN FIRMS TO MARKET RUSSIAN TURBODRILL according to reports of licensing agreements signed in Moscow late last year. Two German oilfield equipment manufacturers will make and sell turbodrills under the license which covers 41 countries. Thirty drills from 5 to 9-in. OD were shipped to Germany this spring.



W-K-M *Creative Engineering* sets the industry standard for Through-Conduit Gate Valves

W-K-M
Recessed Body Valves
for Dual Completion Christmas Trees

These recessed body valves illustrate how W-K-M's creative engineering solves your problems. The recessed body was achieved without impairing the efficiency of the typical W-K-M design. These valves give you the benefits of W-K-M's parallel expanding gates, controlled force seating, free flow through the valve without turbulence or pressure drop, and can be completely overhauled in the line.

Sizes: 1½", 1¾", 2", 2½" and 3". Working pressures, 2000 pounds to 5000 pounds.

WRITE FOR CATALOG 200

The creative engineering behind W-K-M Through-Conduit Gate Valves sets industry standards for design . . . dependability . . . easy operation . . . long life and low maintenance costs. Quality of workmanship and material is rarely duplicated, never surpassed. In the field, service is prompt, skilled and helpful.

ON HAND. The most used sizes of W-K-M Gate Valves are carried by supply stores everywhere. Special sizes and special designs are produced as you need them.

W-K-M

DIVISION OF ACF INDUSTRIES
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P. O. BOX 2117, HOUSTON, TEXAS

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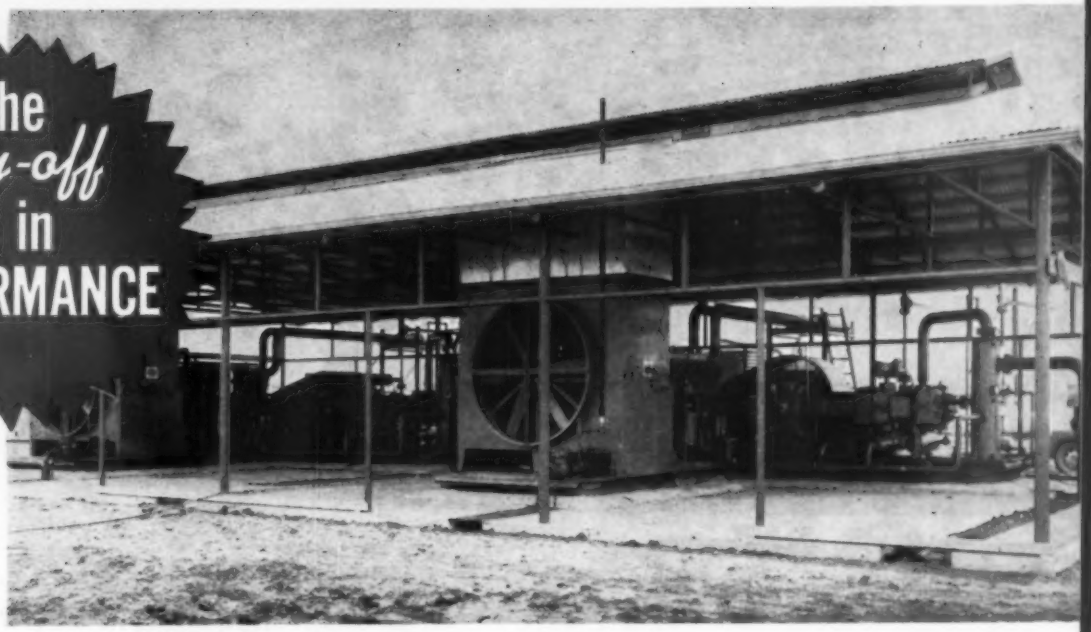
The *Pay-off* is in PERFORMANCE



HANDLING SALES GAS IN SOUTH TEXAS

With An Installation of

WILSON SUPPLY—INGERSOLL-RAND

field compressors

Expert engineering plus careful, complete fabrication of every installation insures minimum shut-down time and eliminates major maintenance costs.

The type "ESH" Compressors are completely new. In them have been incorporated features that assure continuous, low cost operation. They are adequately valved with "A" CHANNEL Valves with "double life" seats in low and medium pressure cylinders and the dependable type "K" valves in the high pressure units.

These features mean profit and satisfaction to you:

- **Completely sealed frame.**
- **Sealed distance-piece.**
- **Full-floating aluminum bearings.**
- **Force-feed lubrication with full flow filter.**
- **Window-type oil level indicator.**
- **Low-oil-pressure protection.**
- **Aluminum crosshead shoes.**
- **Bored crosshead guide.**
- **Full-floating metallic packing.**

WRITE FOR COMPLETE INFORMATION

"WHAT YOU WANT—WHEN YOU WANT IT"

MAIN OFFICE and WAREHOUSE: 1501 FONTI ST.

BRANCH STORES

TEXAS: Alice, Corpus Christi, San Antonio, Victoria, McAllen, Bay City, Columbus, Barbers Hill, Liberty, Beaumont, Kilgore, Odessa, Monahans. LOUISIANA: Lake Charles, New Iberia, Houma, Harvey, Shreveport. NEW MEXICO: Hobbs.

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HOUSTON, TEXAS

SAVE 2 WAYS WITH

MARTIN RUBBER GUIDE CAGES

1. GREATER PRODUCING PROFITS *because:*

Martin Cages last much longer. The oil-proof rubber guides do the trick, by absorbing the ball peen hammer action of the hard balls. They also have superior resistance to sand abrasion. And they can be replaced.

2. GREATER PRODUCING PROFITS *because:*

Ball & Seat life is usually doubled, on the average. With the rubber guides, there is much less chattering, chipping and pitting. Ball falls true on seat. Such improvement in Ball & Seat life eliminates a lot of pulling expense.

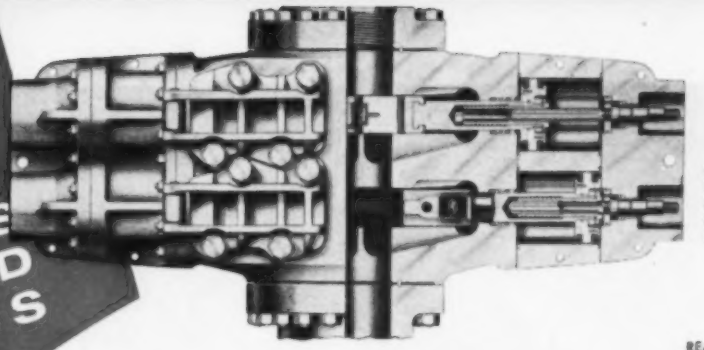
In the last year alone, new users of Martin Cages have increased by 85%. The word is getting around. More and more economy-minded producers are learning about the advantages of the Martin Cages! . . . Manufactured in open and closed types . . . all diameters and styles. Write for John Martin Catalog No. 4 today. *Martin Cages are available through all supply stores.*

JOHN N. MARTIN

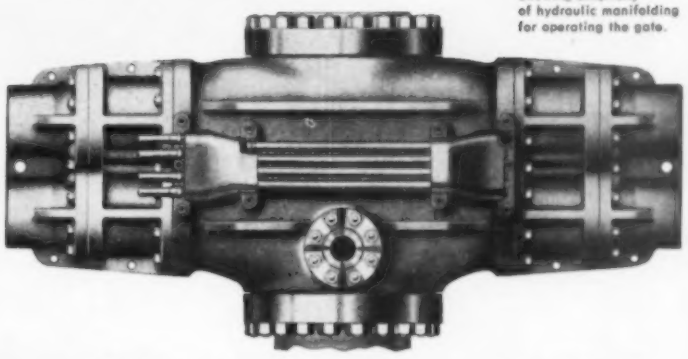
Manufacturer

9 W. BRADY • TULSA, OKLA.

There's only one way to get all of SHAFFER'S ADVANCED FEATURES



CUTAWAY VIEW
Showing direct hydraulic drive and self-draining ram compartments.



REAR VIEW
Showing simplicity of hydraulic manifolding for operating the gate.

...BUY

SHAFFER

CONTROL GATES

SOUNDS ACADEMIC

— and maybe it is. But the point we make is this: — Feature by feature, no other cellar control gate incorporates so many advanced features as do SHAFFER *Gates. So why settle for less when you can get all of these unique advancements by specifying* SHAFFER*?*

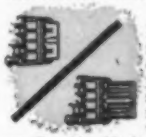
Shaffer Gives You

UNMATCHED CONVENIENCE!

Rams must be changed frequently to fit varying pipe sizes as wells are drilled. With Shaffer Hydraulic Gates there is no need to dismantle the unit to change rams. You simply unbolt patented *side-opening* doors . . . swing them open . . . change rams . . . and bolt the doors shut again. Closing the doors automatically aligns the rams within the gate. And complete ram changes can be made with equal convenience whether the pipe is in the hole—or out!

Shaffer Gives You

GREATER VERSATILITY!



For simplified inventory and maintenance, you can standardize on Shaffer Gates—yet maintain maximum versatility to meet varying field requirements. Shaffer provides a choice of either Single or Double Hydraulic Gates with the same unique design and operating advantages. Also, in each type you have a choice of *Rising* Locking Shafts (where quick indication of ram position is desired) or *Non-Rising* Locking Shafts (where maximum compactness is desired). Rams and most other parts are interchangeable, size for size!

Shaffer Gives You

SPACE-SAVING COMPACTNESS!

Cellar equipment that is bulky can take a high toll in greater rig costs, larger cellars, clumsy hook-ups. But Shaffer Gates are unusually compact in *all three* dimensions—height, width, and length. Furthermore, no extra space need be allowed above gate—or at ends—for servicing rams. **Result**—even in sizes as large as 13⅝" (12" Series 900) the Double Gate has a *total* height of only 30" . . . the Single Gate only 18½". *No extra space need be allowed above or at the ends for ram changes.*

Shaffer Gives You

OTHER ADVANTAGES!

Still other Shaffer advantages that save time, boost efficiency and assure better performance include **Self-Draining Compartment Bottoms** with rams traveling on high guide ribs where no detrimental mud and sand can accumulate . . . **Simple, Direct Drive** with operating pistons *directly behind* rams for maximum power, fewer parts, positive simplicity . . . **Completely Enclosed Design** with no exposed moving parts to jam or corrode . . . and many other unique features.

35 years OF OIL TOOL LEADERSHIP

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
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OKLAHOMA CITY, OKLAHOMA, Shaffer Tool Works, 6201 South Shields Boulevard
FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 546
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
HOUMA, LOUISIANA, Shaffer Tool Works, Post Office Box 827
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

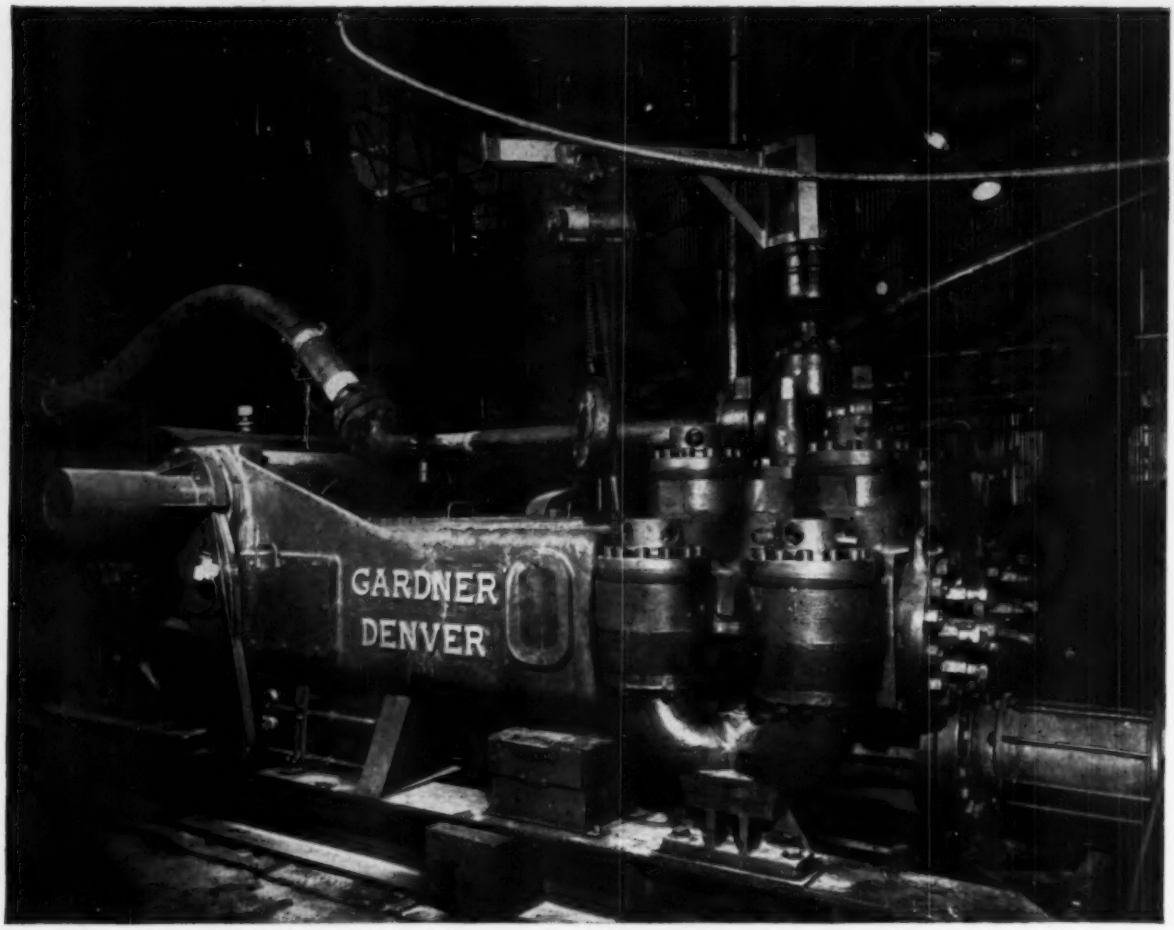
REMEMBER—

Shaffer also manufactures a complete line of *Mechanical* Cellar Control Gates—both Single and Double Types—for those desiring this type of equipment. Ram Blocks and Ram Rubbers are interchangeable, size for size, with those in Shaffer Hydraulic Gates, assuring further savings where both types of gates are used.

See your nearest Shaffer representative for complete details—or write direct!

Send for your free copy of the latest Shaffer Catalog!

Shaffer products are described in your Composite Catalog!



Things to look for when choosing a mud pump

- Rigid main frame—to keep parts in alignment and withstand heavy-duty loads.
- Eccentric construction—for smooth operation and extra resistance to high plunger loads.
- Large-diameter bronze bearings—reduce unit bearing loads, cushion shock loads.
- Divided fluid cylinder end—individually replaceable cylinders speed maintenance.
- "Slush Proof"® valves—rubber inserts absorb closing shock.
- Large-radius intake manifold—for smoother mud flow and better suction.
- Mud-tight power end—that keeps oil in and mud, dust and rain out.
- Parts accessibility—all parts accessible for field servicing.
- Service and parts facilities—parts and factory-trained pump service specialists readily available.

These are the points that have made Gardner-Denver mud pumps first choice throughout the oil fields.

Write for information on Gardner-Denver mud pumps for any capacity and pressure need.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

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Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario
Gardner-Denver Export Division, 233 Broadway, New York, N. Y.

Oil field offices: Dallas, Houston, Tulsa, St. Louis, Los Angeles, New York, Pittsburgh, Denver, New Orleans, Durango, San Francisco, Kansas City, Winnipeg, Edmonton

FOR FURTHER INFORMATION ON
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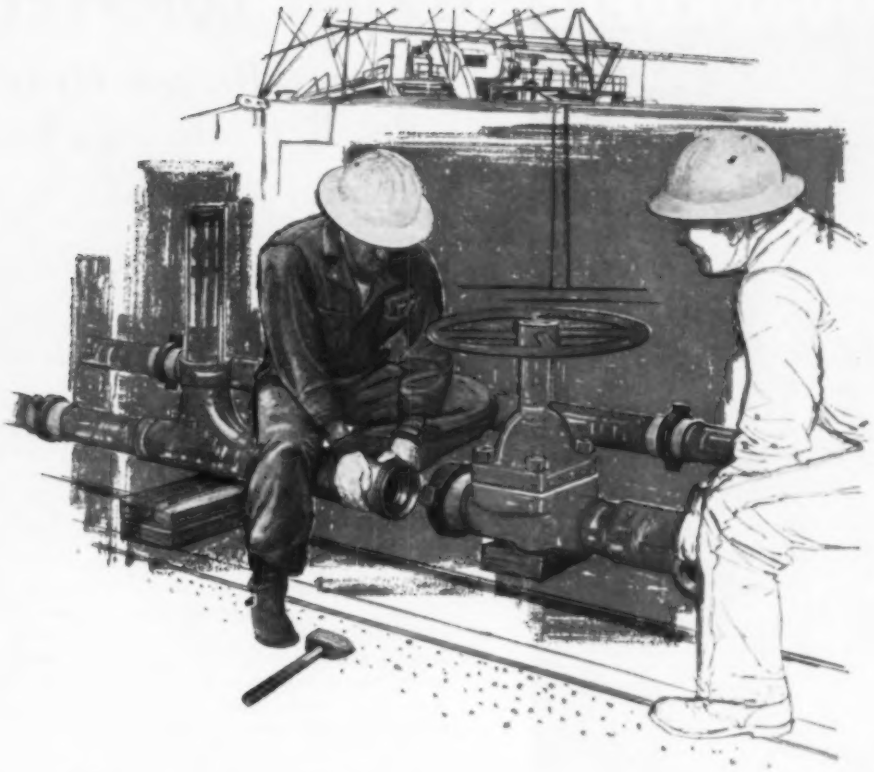


Hurry up!

YOU DON'T HAVE TO BABY WECO UNIONS

Your rigging-up goes at top speed when you've got WECO on the job. High grade steel, forged into strong subs and nuts enables WECO Unions to take the rough handling of fast make-up on job after job. Positive action of WECO's full circle ball and cone metal-to-metal seating provides perfect sealing under all service conditions.

You never have to worry about high-pressure, shock, surge or vibration breaking the seals on your WECO equipped piping.

WECO Unions are available at supply stores everywhere, in sizes 1" through 12", in pressures from 1,000 through 15,000 psi.

U-2-58

WECO®

WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS

Division of CHIKSAN COMPANY *a subsidiary of*
FOOD MACHINERY AND CHEMICAL CORPORATION

FIRST QUADRUPLE STRING COMPLETION

Utilizes Brown Hydraulic Set Retrievable Packers

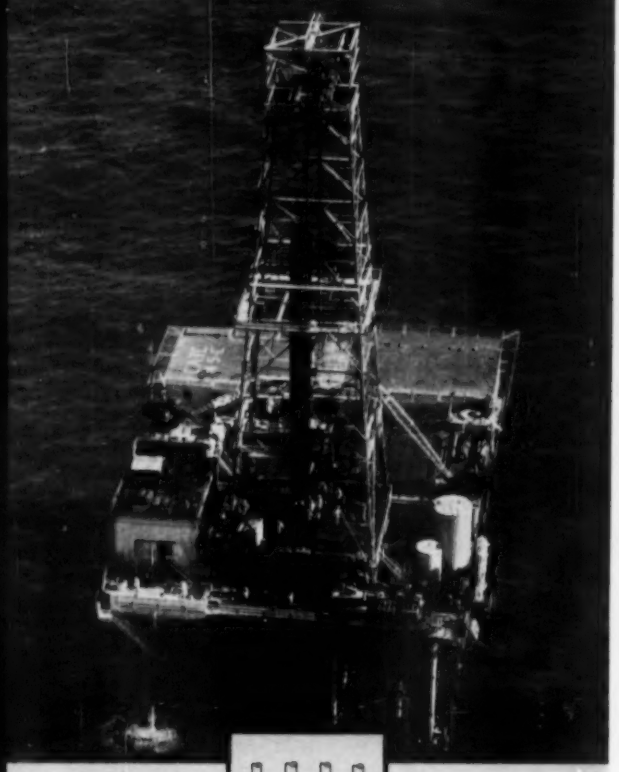
Oil Industry history was made in June of this year when the first quadruple string completion was made in an oil well by the CATC Offshore Group (Continental Oil Co., Atlantic Refining Co., Tidewater Oil Co., and Cities Service Production Co.). The well, the West Delta Block 30 Field, State 970, No. C-8, is located in offshore Plaquemines Parish and is the first well in history to produce four different zones through four individual tubing strings.

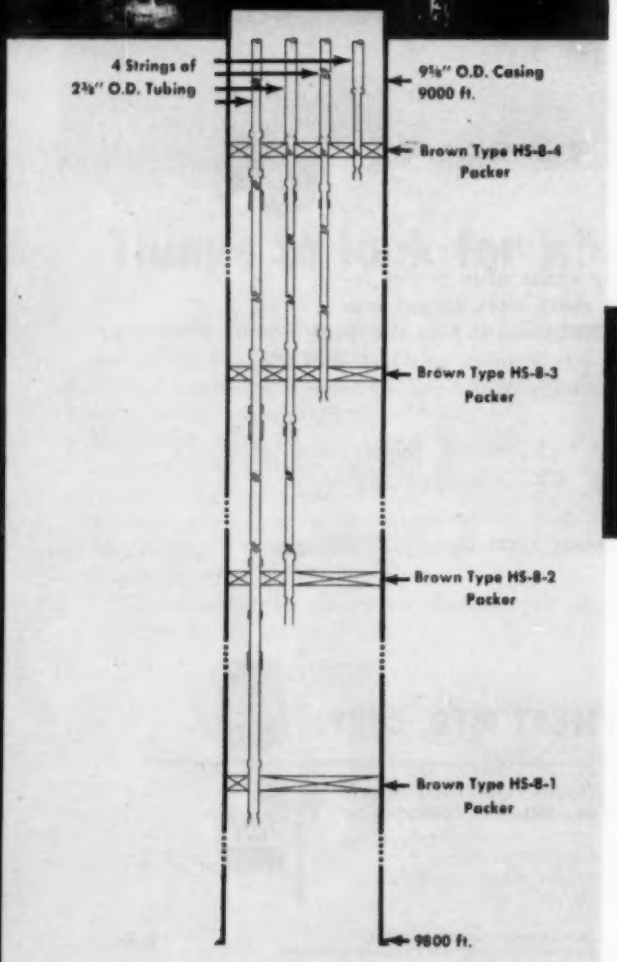
Four Brown Hydraulic Set Retrievable Packers were used in the well completion operation and installed by Brown Service Engineers. All four packers were run on the number one string and set in the interval of 9,000 to 9,800 ft. Each packer was set individually and tested from both directions prior to setting the next packer.

Years of research and testing went into the development and manufacture of the HS-8 Series packers. Single and dual Hydraulic Set Packers were successfully used over two years ago. A short time later, after continuous research, the triple string packer was perfected and accepted by the industry. Now, the development of the first quadruple string packer marks another engineering milestone in Brown's long history of firsts.

Brown equipment was used in the first detachable dual string completion, the first detachable triple string completion, and *now*, the first quadruple string completion.

Let "P·R·I·M·E Completions by Brown" save you money. For complete brochure on Hydraulic Set Packers write Brown Oil Tools, Inc., P. O. Box 19236, Houston 24, Texas.





Packers used in CATC quadruple string completion

BROWN
OIL TOOLS, INC.

8490 Katy Road, Houston, Texas.

Your Well Is Safe With

RECTORHEADS

the head that seals with the Ring-of-Steel

More than 125,000 Rector casing head installations prove that you can forget about pressure leaks when your well is equipped with Rectorheads. For working pressures to 15,000 psi . . . regardless of temperature extremes . . . the Rector ring-of-steel provides a lifetime seal.

There is no resilient packing to flow under pressure or deteriorate from heat or time. The casing is welded to a steel ring that fits in a precision ground seat. There is no stress on the weld when the flange bolts are tightened. A steel API ring gasket completes the permanent, maintenance-free seal.

For well safety and long range economy, specify RECTORHEADS . . . now in sizes through 20". Order from your favorite SUPPLY STORE.

RECTOR WELL EQUIPMENT COMPANY INC

★ MAKING THE OIL INDUSTRY SAFER

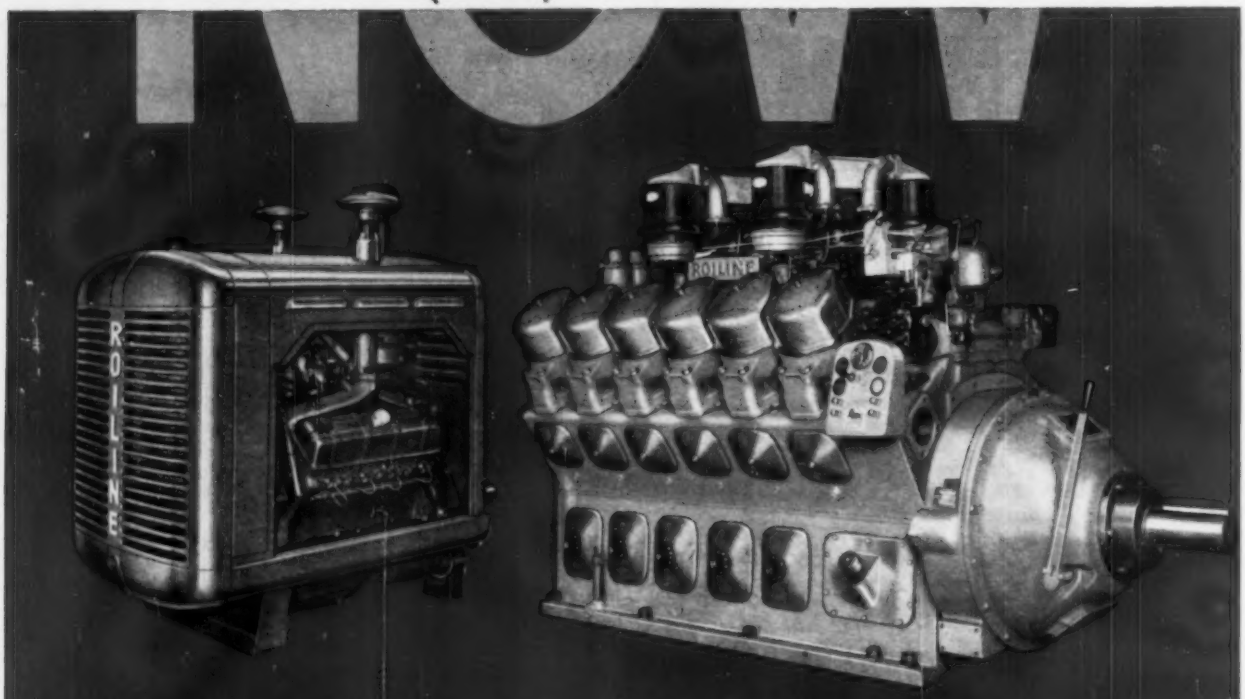
1100 NORTH COMMERCE ST. FORT WORTH, TEXAS

Houston Plant: 2215 Commerce St.

EXPORT REPRESENTATIVES: Continental Supply Company • Mid-Continent Supply Company • Oil Well Supply Company

NOW

ROILINE ENGINES (formerly LE ROI) ARE BUILT BY WAUKESHA.....



8-Cylinder H-540 ROILINE Unit—to 163 hp

V-12 L-4000 ROILINE Engine—to 685 hp

THESE FORMER LE ROI MODELS BECOME WAUKESHA ROILINE ENGINES

Model	Bore and Stroke	No. of Cyls.	Disp. Cu. in.	Max. Torque Lb./Ft. @ RPM	Brake Horsepower at Engine Speeds Indicated 600	800	1000	1200	1400	1600	1800	2000	2200	2400
H540	4½ x 4¼	8	540	454.... 900		68	87	105	122	138	151	164	173	178
H844	5¼ x 4½	8	844	671....1500		113	145	177	205	231	255	274	290	299
F1500	6⅜ x 7	6	1503	1165.... 650	134	176	214	230						
H2000	6⅜ x 7	8	2004	1590.... 650	180	240	290	300						
L3000	6¾ x 7	12	3006	2420.... 650	275	360	435	460						
L3460	7¼ x 7	12	3468	2750.... 900	305	416	527	608	635 @ 1350 RPM					
L4000	7.54 x 7.5	12	4000	3110.... 900	345	471	595	685						

These are engine ratings on LP Gas . . . send for Power Chart with ratings for engines and complete power units operating on natural gas, LP Gas, and gasoline.

WAUKESHA MOTOR COMPANY

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Waukesha MOTOR

.... under famous Waukesha Quality Control

ROILINE ENGINES (formerly Le Roi)

THE ADDITION of these well-known gas and gasoline engines to the Waukesha line... produced by Waukesha engine-builders and sold through the former Le Roi engine distributors... is of great importance to all users of internal combustion engine power.

The principal models of Le Roi gas and gasoline engines, formerly built by the Le Roi Division of the Westinghouse Airbrake Company, have been sold to the Waukesha Motor Company. The engines listed on the opposite page will be known as Waukesha "ROILINE" engines, and be built as bare engines, complete power units, and with components and accessories for special services.

Le Roi engines are widely used in the oil industry, and in various types of cotton ginning, compressor, generator, and pumping installations. They have been well-known in these fields and in other internal combustion engine applications for many years.

Waukesha has all rights to the manufacture and sale of these former Le Roi engine models and the service parts, patterns, and designs. Waukesha will produce the V-8 models H-540 and H-844 high speed transport and industrial engines in the Waukesha plant. The remainder of the engine models, including the in-line Six and large V-8 and V-12 engines, will be manufactured in Waukesha's Climax Division plant at Clinton, Iowa. ROILINE engines, parts, and service will be available in all sections of the country to owners, operators, and purchasers of these fine engines, through the ROILINE distributor organization. OEM accounts normally serviced directly by the manufacturer will be handled through the Waukesha headquarters sales office.

This expansion of Waukesha's production will enable Waukesha to manufacture and supply internal combustion engine power for any requirement from 6 to 1200 horsepower in all normal speed ranges and for use with all standard fuels.

• *The trade mark LE ROI is used under license from Westinghouse Airbrake Co., the trade mark owner.*

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SEE YOUR ROILINE DISTRIBUTOR

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ARKANSAS
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CALIFORNIA
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Ingersoll Corporation

OHIO
Columbus
Cantwell Machinery Company

OKLAHOMA
Chickasha
Chickasha Gin & Mill Supply
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Carson Machine & Supply Co.

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P. C. McKenzie Company

TEXAS
Houston
Southern Engine & Pump Co.
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Farmers Supply Company
Odessa
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Wichita Falls
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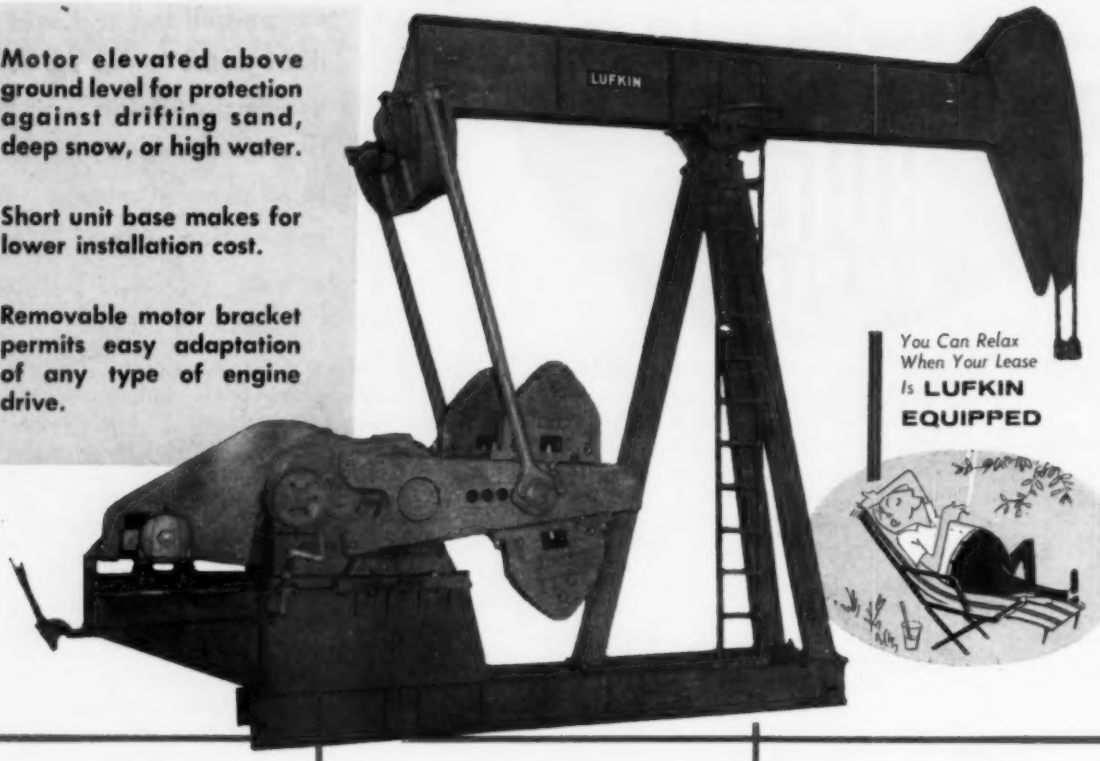
LUFKIN'S NEW HI-PRIME UNIT

OFFERS MAXIMUM FLEXIBILITY IN PRIME MOVER APPLICATION

△ Motor elevated above ground level for protection against drifting sand, deep snow, or high water.

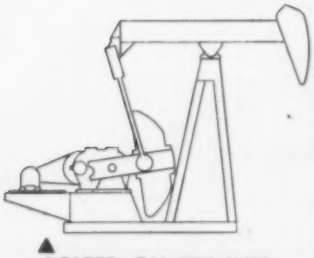
△ Short unit base makes for lower installation cost.

△ Removable motor bracket permits easy adaptation of any type of engine drive.

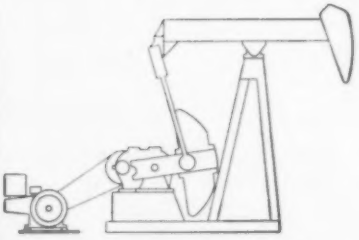


You Can Relax When Your Lease Is **LUFKIN EQUIPPED**

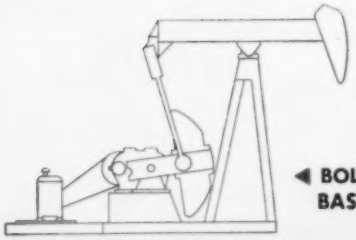
A new unit with the same old ruggedness and dependability which makes LUFKIN first in the pumping unit field.



▲ **BOLTED ON BRACKET FOR ELECTRIC MOTOR**



▲ **STUB BASE WITH ENGINE SET SEPARATELY**



◀ **BOLTED EXTENSION BASE FOR GAS ENGINES**

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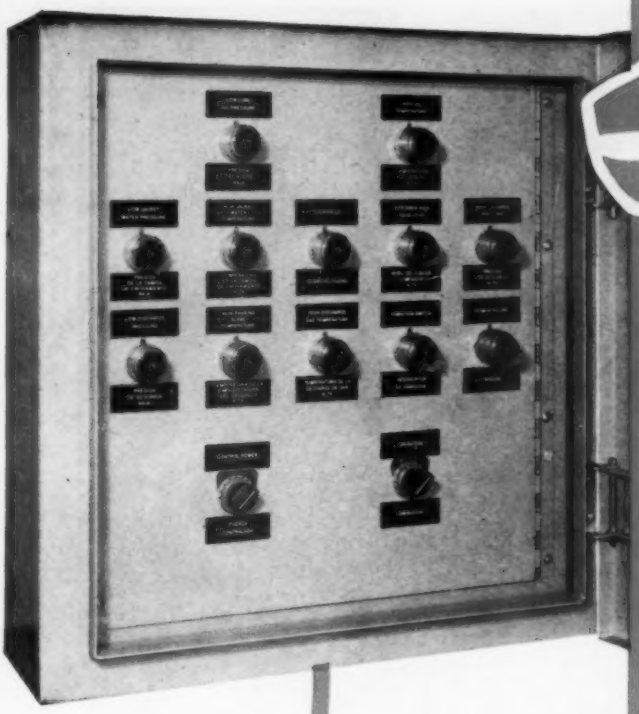
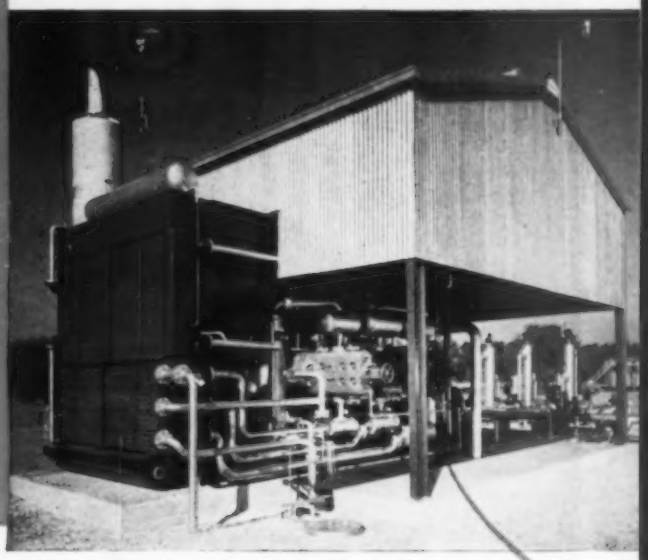
Lufkin equipment in Canada is handled by

THE LUFKIN MACHINE CO., LTD., 9950 65th Avenue, Edmonton, Alberta, Canada, Regina, Saskatchewan, Canada



Southwest



NOW THE NEW PANEL CONTROL FOR UNATTENDED COMPRESSOR STATION OPERATION

Southwest Packaged Gas Compressors can now be furnished with automatic shutdown and panelboard indicator equipment custom built to the particular requirements of your station.

Any combination of automatic shutdowns, working through a solenoid controlled valve in the fuel gas system, protects your engine against malfunction.

During normal operation, the signal lights on the panelboard remain off. When any one control switch becomes actuated due to abnormal operation, the signal light corresponding to that switch goes on. The engine shuts down automatically. All other relays are locked out, and the one signal light remaining on indicates the exact switch which caused the engine to shut off.

As many as fifteen separate functions can be pinpointed by this panel indicator. Your maintenance men can get your compressor back on stream faster.

Southwest engineers will give you full details on this protective equipment for unattended compressor operation.

This is another development by Southwest to improve the operation of Packaged Gas Compressors.

DESIGNERS AND MANUFACTURERS OF PACKAGED INERT GAS COMPRESSORS, PACKAGED CO_2 REMOVAL UNITS, AND PACKAGED GAS COMPRESSORS.

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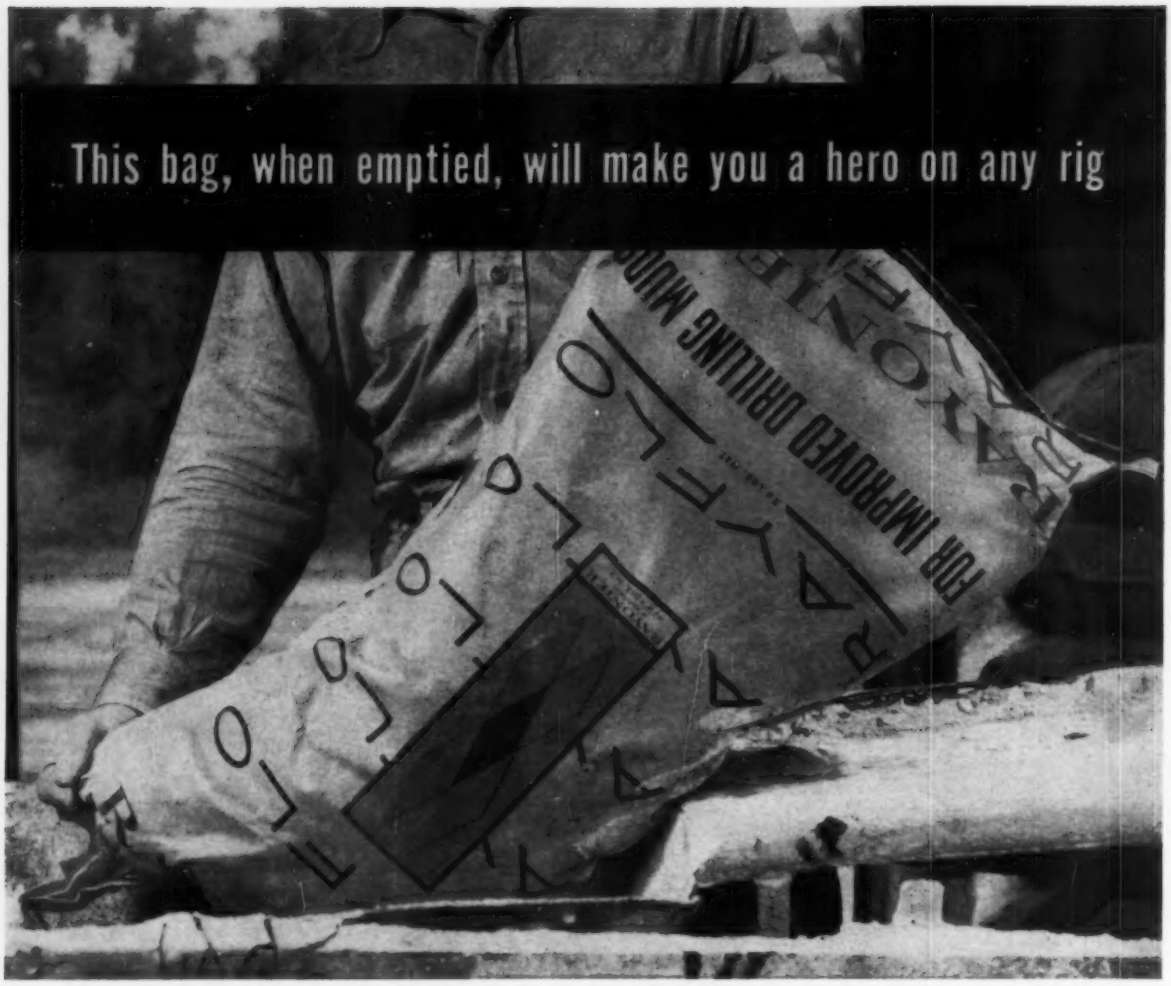

Rayflo saves thinner, time, money and sweat!

As an oilman you want economical and efficient drilling operations. Rayflo is the *one* dispersant that can promise you peak performance of muds under problem conditions.

Because Rayflo is a chemical exclusively designed for problem drilling (and manufactured under rigid chemical controls), it offers matchless uniformity plus full effectiveness in controlling viscosity and gel strengths.

It's no secret that throughout the oil and gas world, Rayflo is saving thinners, time, money and sweat and outperforming all other dispersants.

Ask any savvy oil man. Or for more facts, write to: **George E. Durkee,** Technical Representative, Rayonier Incorporated, 161 East 42nd St., New York 17, N. Y. Of course, no obligation to you.

FOR UNCOMMON SAVINGS ***The Newest Dispersant—TANFLO, a Rayflo blend***

New, low-cost Tanflo—scientifically blended with Rayflo—is compatible with most additives. Uniform in composition and effect, Tanflo holds mud costs to a minimum.

Get the full Tanflo story—and samples—today!

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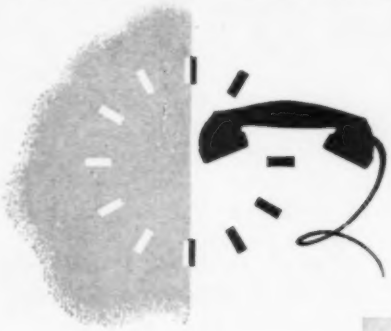
HOW TO CUT PRODUCTION COSTS
WITHOUT GOING NEAR THE LEASE

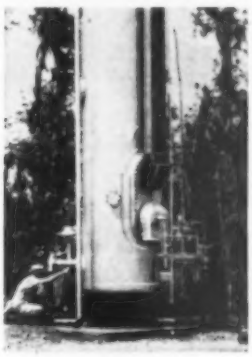


. . . call TRETOLITE

Your Tretolite field service engineer is always on call . . . always ready to help you. He will gladly survey your treating operation to make sure it is as efficient as it can be.

Here are some important treating factors he will check:

1 TREATING CHEMICAL. Is it the best for your operation? Your Tretolite engineer will make tests and make sure.



2 MECHANICAL OPERATIONS. A faulty pump, a damaged valve, and many other mechanical factors can affect the severity of emulsification. Your Tretolite engineer will consult with you on such possibilities.

3 CHEMICAL-HEAT BALANCE. Sometimes a little more chemical or a more efficient chemical can be used to reduce heating. The use of less heat can cut vapor losses which reduce gravity. Often a few points gain in gravity can earn a better selling price. Your Tretolite engineer will be glad to check this phase of your operation for you.

4 CHEMICAL PUMP – CHEMICAL RESERVOIR. Chemical pump malfunction can cause trouble, so can a dirty chemical supply tank. Your Tretolite field service engineer will go over your chemical feed procedure and equipment—carefully, knowingly.

Ask the Man in the Red Car
It's the Tretolite Field Service Engineer's job to help you produce salable oil for less money. There is no charge for this service.

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DIVISIONS OF PETROLITE CORPORATION
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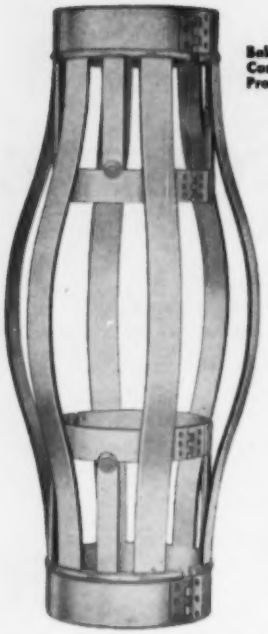
TF-58-8



Baker Model "H-20"
Casing Centralizer
Product No. 9112

a size and type...

Model "H-30"
(3" Bowed Height)
Product No. 9114

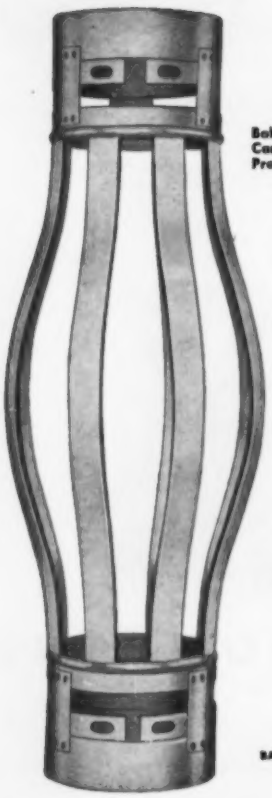
Model "H-25"
(2½" Bowed Height)
Product No. 9113

Model "H-15"
(1½" Bowed Height)
Product No. 9115

Model "H-20"
(2" Bowed Height)
Product No. 9112

"TAILORED" to your needs because Baker Casing Centralizers are made with bowed height ("effective reach") of springs from 1¼" to 5"—for a range of open hole diameters from 5⅜" to 26½"—and to run on casing sizes from 4½" to 16". It's easy to see that the *exact* size is available to fit *your* casing and provide effective centering in the greatest practical range of open hole diameters.

"tailored" to your needs...



Baker Model "G-20"
Casing Centralizer
Product No. 910-G

Model "G-30"
(2" Bowed Height)
Product No. 910-G

Model "G-15"
(1¼" Bowed Height)
Product No. 910-G

Model "G-15"
(1½" Bowed Height)
Product No. 910-G

"TAILORED" to your wishes, and you can choose between the Baker Model "H" HINGE-LOK Centralizer which is closed and locked around the casing coupling or stop ring—or you may prefer the Baker Model "G" SLIP-ON Centralizer which is merely slipped over the casing and positioned with stop rings.
Ask the Baker representative about "Protective" primary cementing using Baker Casing Centralizers in combination with Baker Wall Scratchers and Baker Cementing Shoes and Collars.

for better cementing

One of the partners in
BAKER "Protective" Cementing

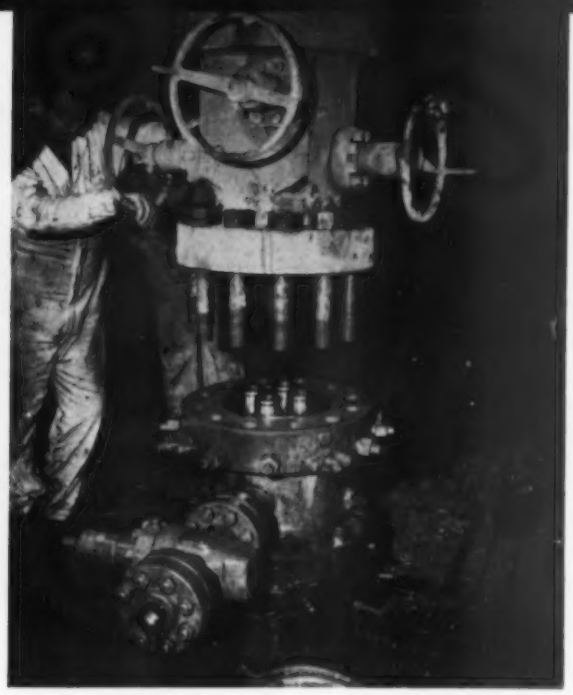
Baker Flexiflow Fill-Up Collars and Shoes
Baker Casing Centralizers
Baker Wall Scratchers

BAKER
CASING CENTRALIZERS

BAKER OIL TOOLS, INC. HOUSTON • LOS ANGELES • NEW YORK

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

First quadruple parallel string solid block tree when first set on location. The tree, constructed from a single-forged steel block with four dual sets of master valves, was built, tested, and delivered by its manufacturer in 23 days.— *Photo courtesy Cameron Iron Works, Inc.*



Tree is lowered onto quadruple completion spool with triple seal segmented hangers which were located automatically when lowered into place. The hangers use back pressure valve for closed pressure completion.

CATC Makes . . .

P 459.6

First Four-String Quadruple Completion

- **Solid block tree, hydraulic-set packers, color-coded tubing ease parallel string completion in Louisiana offshore well**
- **Four zones produce total of 1200 bbl of oil, 570,000 cu ft of gas between 9022 and 9789 ft in deviated hole**

W. W. Poimboeuf,
District Engineer
and
Robert Henderson,
Production Engineer
Continental Oil Company
Harvey, Louisiana

FIRST COMPLETION of an offshore oil well in the Gulf of Mexico from four different producing zones, using four strings of tubing, has been successfully made by the CATC Offshore Group.

The CATC Group consists of Continental Oil Company, Atlantic Refining Company, Tidewater Oil Company and Cities Service Production Company. Conoco serves as operator for the group.

On completion the well, the West Delta Block 30 field State 970 No. C-8, flowed a total of 1200 bbl of oil and 570,000 cu ft of gas from four different pay zones between 9022 and 9789 ft. All completions were through an 8/64-in. choke and the gravity of the oil was 31.4, 31.8, 29.1, and 26.6 deg.

The well is located about 12 miles off Louisiana's Southwest Pass in Plaquemines Parish, at the mouth of the Mississippi River. It is the eighth well to be drilled by CATC from a large, self-contained platform in the Block 30 field, discovered in 1949. CATC has 27 wells in the field.

Multiple Completion Experience

Dual completions were fairly commonplace when the CATC Group's Harvey, Louisiana, district began offshore operations in 1953.

To date CATC has dually completed 25 multiple pay wells. On October 27, 1957, the group's Harvey district made its first triple completion of an oil well. Since that time, CATC has made 12 such triple completions.

Quadruple Requirements

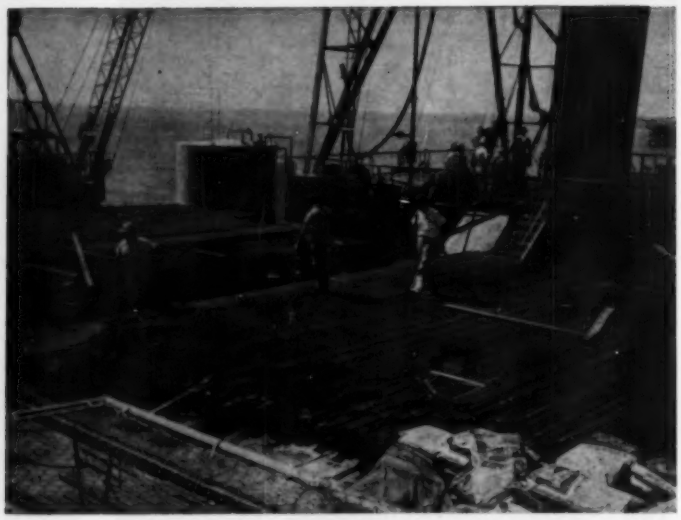
A quadruple completion using four strings of tubing was first considered shortly after several triple-string completions had been installed successfully and economically for the CATC Group. During the initial planning stages, it was concluded that, to make the quadruple completion, the well should have the following characteristics: (1) The producing zones should be relatively close together; (2) the four zones should show promise of a long producing life, and (3) the wells should show a possibility of a long-flowing life so that artificial lift or rework would not be necessary during the early productive stages.

CATC's West Delta Block 45 Well No. C-8 satisfied these requirements. This well is located in the West Delta Block 30 field, approximately 12 miles off the coast of Louisiana in the Gulf of Mexico. The well was directionally drilled a distance of 1326 ft from the surface location from a self-contained drilling platform.

INITIAL PREPARATION

Representatives of completion equipment manufacturing companies were called in and asked to bring any available information pertinent to such a completion. The Christmas tree for this installation was designed, forged, constructed, tested and shipped by the manufacturer within 23 days after this consultation. The tree combines into

Inspecting the quadruple packer at the CATC well are G. O. White, Brown Oil Tool Company; George B. Grafton, CATC district superintendent; C. D. Armstrong, CATC district drilling superintendent, and Red Chambers, Brown Oil Tool.



Some 35,000 ft of tubing used in the well. Packers were assembled and spaced out in the warehouse yard in Harvey. Tubing used in spacing out the packers were painted in a color code and shipped out to the rig, saving a considerable amount of time.

one forged steel block all valves and flow tees which previously had been flanged, bolted and sealed together for wellhead flow control of oil or gas.

The solid block eliminates flanges, the sources of possible leaks and blowouts. It makes the trees lighter, more compact and stronger, and effects metal savings.

The first quadruple string solid block tree in the oil industry utilizes a special alloy formula. It was constructed from a single-forged steel block with four dual sets of master valves. Due to the integral design of the tree, cross trees were eliminated. The tree was API Series 1500 with a 10-in. tubing head flange. The tubing hanger was split in four 90-deg segments of a circle.

Packer

The packer design was already on the drawing board. It was the hydraulic-type set design which had been run in several triple completions for other operators. The packer design incorporates the use of hydraulic pressure to actuate a piston and cylinder setting mechanism.

Briefly, the packers are set individually by sealing off each respective tubing string with a bakelite ball and applying pressure to the tubing. Differential pressure in excess of 4000 psi shears the pins, sets the slips, and collapses the sealing element. A type CC (criss-cross thread) safety joint was recommended for use on the long tubing string immediately below each packer. This recommendation was made due to the possibility of being unable to rotate the long tubing string through all packers.

The packers are released by rotating the long string. The design of this equipment facilitates the running of all connecting strings below the quadruple packer with the long tubing string. All packers were run on the number one string.

Unions

Special unions were incorporated on the bottom of the quadruple and triple packers to tie the second and third connecting strings into the packers. A pressure-actuated, collet-type stinger latch was designed specifically for this installation. This was necessary because of the possibility of pumping the second and/or third string connecting stinger out of the packers during setting operations.

The stingers for the second, third, and fourth strings for the quadruple packer were (j) type latches. This equipment was run in the manufacturers' test well in Houston with operator's personnel present. The equipment performed satisfactorily. A discussion was held at this time to try to determine what problems could arise during the actual completion. The packers were then inspected and redressed, and shipped to the operator's warehouse.

While completion preparations were being conducted on Well C-8, the packers were assembled and spaced out in the warehouse yard. The tubing used in spacing out the packers was painted in a color code and shipped out to the rig. Thereby, a considerable amount of time was saved at the rig since it was not necessary to space out the packers while they were being run in the hole.

COMPLETION OPERATIONS

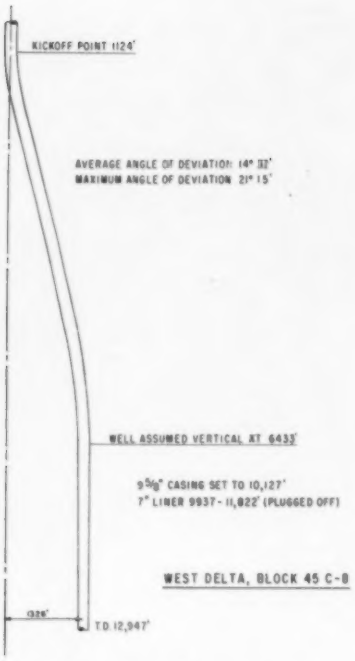
The well was plugged back to 9820 ft inside the 9⅝-in. casing. Since mud has a tendency to set up behind packers when it is exposed to high bottom-hole temperatures, it was decided to displace the mud system with a completion fluid that would not set up. All of the completion zones were new sands and their exact bottom-hole pressure was not known. Therefore, it was decided to drillstem test the lower zone to determine the maximum bottom-hole pressure that would be encountered.

A 2-ft section in the bottom of the lower zone was perforated with four jet shots per foot, and a drillstem test was taken. The bottom-hole static pressure was determined to be 5755 psi. It was decided that a 12.2 lb per gal completion fluid would be adequate. This fluid would give approximately a 300 psi overbalance at 9500 ft TVD. The perforations 9808-10 ft were squeezed off with 200 sacks of slo-set cement.

Block Squeeze

To insure the primary cement job and to prevent water channeling from the numerous water-bearing sand stringers scattered throughout the interval that included the productive zones, each producing zone was block squeezed beginning with the bottom zone. A 2-ft section was perforated in the vicinity of each producing zone and a block squeeze was performed with 200 sacks of slo-set cement. The cement was drilled out and a dry test was taken on each set of squeeze perforations with the exception of the lower set, which was left plugged.

After a dry test had been obtained on each set of squeeze perforations,


KICKOFF POINT 1124'
AVERAGE ANGLE OF DEVIATION 14° 32'
MAXIMUM ANGLE OF DEVIATION 21° 15'
WELL ASSUMED VERTICAL AT 6433'
9⅝" CASING SET TO 10,127'
7" LINER 9937 - 11,822' (PLUGGED OFF)
WEST DELTA, BLOCK 45 C-8
1326'
TD 12,947'

CROSS SECTIONAL VIEW OF DIRECTIONAL HOLE

Well was directionally drilled a distance of 1326 ft from the surface location. Due to excessive drag in the deviated hole, it was necessary to add 2 ft to original pipe measurements to get enough weight to force the stinger into the packer on the third and fourth tubing strings.

the mud system was displaced with fresh water. The water was weighted to 12.2 lb per gal with sodium nitrate and calcium chloride, using one to two ratio by weight of the respective materials.

Plastic Squeeze

A good deal of trouble had been experienced in this field with sand incursion. Therefore, it was decided to perforate only a 5-ft section of each producing zone and squeeze each zone with sand consolidation plastic. It was felt this would partially eliminate the possibility of any early workover for this well.

The single and dual packers were run in the hole on the long string to the point where the triple packer was to be installed. The long string was hung in dual tubing slips and the second string connecting tubing was run and stabbed into the dual packer. The triple packer was then made up on the number one string and the number two string was tied to the packer with a union. This equipment was lowered on the number one string to a point where the quadruple packer was to be installed.

The number one string was again hung in the dual slips and the number two connecting string was run and stabbed into the proper port in the triple packer. The number one string was then hung in the elevators and the number two string was clamped off on the drive bushings. The number three connecting string was then run and stabbed into the third port of the triple packer.

It should be noted that the proper port for these strings was designated by the stinger size, the second port being larger than the third. The quadruple packer was made up on the long string and the numbers two and three connecting strings were unioned to the packer. All this equipment was run in the hole to the predetermined depth on the number one string and landed in the tubing head.

A latch-type stinger was made up on the second string and run in the hole. Some difficulty was encountered in stabbing the stinger into the proper port in the quadruple packer, even though the second string port was larger than the third and fourth string ports. After failing to stab the stinger in the quadruple packer, the number two string was pulled. To avoid idle rig time while waiting on a new stinger for the second string, the third and fourth strings were run to 6500 ft and hung. The new stinger was then installed on the second string and it was run.

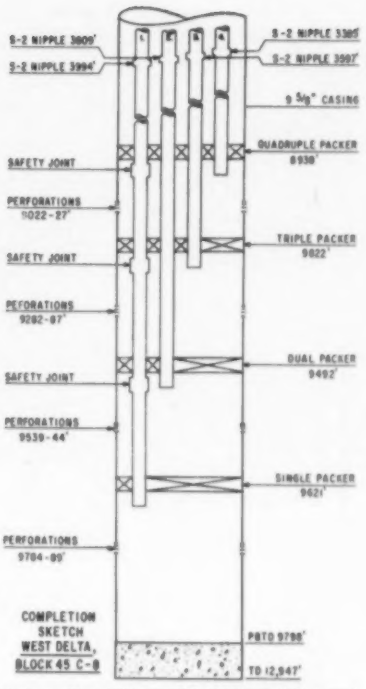
Directional Hole Difficulty

Due to excessive drag in the directional hole, it was necessary to add 2 ft to the original pipe measurements to get enough weight to force the stinger into the packer. The third string was then run and stabbed into the quadruple packer without any difficulty. The number three string also had to be overspaced to get enough weight to stab into the quadruple packer. Attempts to stab the number four string in the quadruple packer were unsuccessful.

After working the number four string for a considerable amount of time, it was decided to pick up the blowout preventers and add a 2-ft section to the number one string to take the suspected bow out of the number two and number three strings. After adding the 2-ft section to the number one string, the number four string was stabbed without difficulty.

Testing

The Christmas tree was then installed and reverse circulation was was established through all four tubing strings to be sure there were no obstructions in the tubing. The packers were then set in reverse numerical



Schematic of the well's tubing string and packer placement. Well was originally drilled to a depth of 12,947 ft, but plugged back to 9798 ft. A 2-ft section was jet perforated to determine bottom-hole static pressure at 9808-10 ft. These were then squeezed off with 200 sacks of slo-set cement.

order. A 1⅝-in. bakelite ball was pumped down the number four string to the seating point. The setting pressure was built up to 5000 psi, and the casing was pressured up to 1200 psi to test the packer.

The setting ball was reversed out of the number four tubing string by pumping down the number three tubing string. The number three and number two packers were set in the same manner. The number three packer was tested by placing 1000 psi pressure on the number four tubing string. The number one packer was set by pumping a 1¾-in. ball down the number one tubing string and building up approximately 5000 psi setting pressure.

The number one packer was tested with 1000 psi by pumping down the number two string. The ball was flowed out of the number one string when the well was brought in. It should be noted that the ability to selectively circulate around the packers in the unset position proved to be a major gain in an installation of this type.

The wells were swabbed in and tested. The following is the results of these tests:

Zone	Perforations	BOPD	FTP	GOR	Gravity	BS&W
C-8	9784-89'	300	1750	317	27.8	.1%
C-8D	9539-44'	287	2250	523	32.2	.1%
C-8T	9282-87'	296	2450	540	29.8	.1%
C-8Q	9022-27'	241	2400	528	29.0	.1%

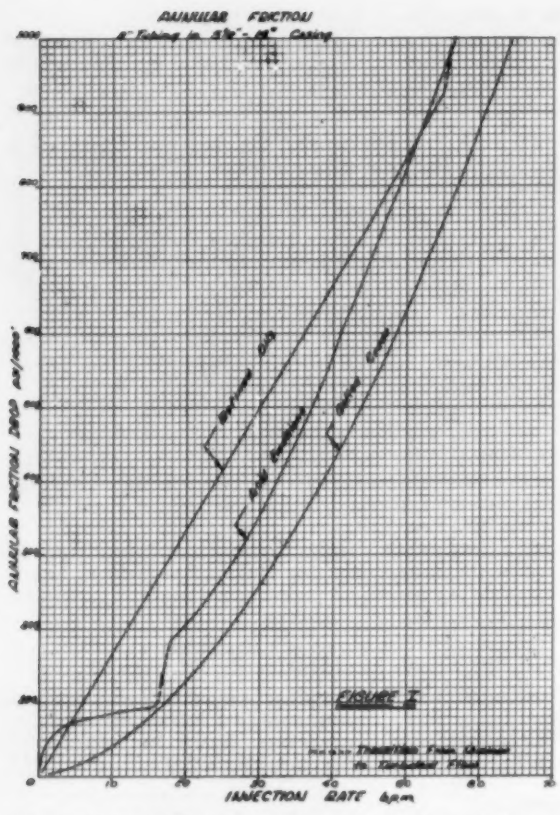


FIG. 1. **Annular friction loss** between 2-in. tubing and 5½-in., 14-lb casing for three popular frac fluids.

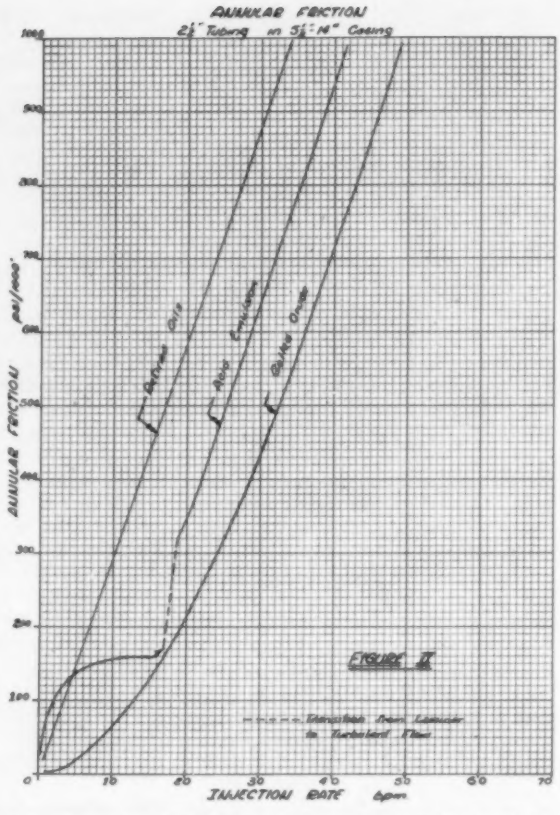


FIG. 2. **Annular friction loss** between 2½-in. tubing in 5½-in., 14-lb casing when injecting at various rates for three types of frac fluids.

How to calculate and apply

Annular Friction Losses Between Tubing and Casing

When treating a well down the annulus, will you exceed pressure limitations . . . can you achieve desired injection rates . . . how much hydraulic horsepower is needed? Here is a field-substantiated method to answer these and other questions

Robert Wade Brown
The Western Company,
Midland, Texas

WELL TREATMENTS by acidizing or fracturing can be planned more efficiently and with more effective results when friction losses are known. Pressure losses when injecting down the tubing or down the casing with the tubing pulled have been determined and used with good results.[1,2] Well stimulation by acidizing or fracturing is also performed on a large number of wells where the operator — for a number of reasons — does not wish to pull the tubing.

In this case, what are the factors to be considered prior to the treatment? Would it be better to inject simultaneously down both the tubing and the casing annulus? Can desired injection rates be maintained without exceeding casing pressure limitations? How much hydraulic horsepower will be required on the surface in order to achieve the best treatment? By knowing the friction losses down the casing annulus (and the tubing where required), these questions can be answered more realistically than by the usual "experienced guess."

The pressure drop due to friction of various types of fluids in the annulus of several combinations of tubing and

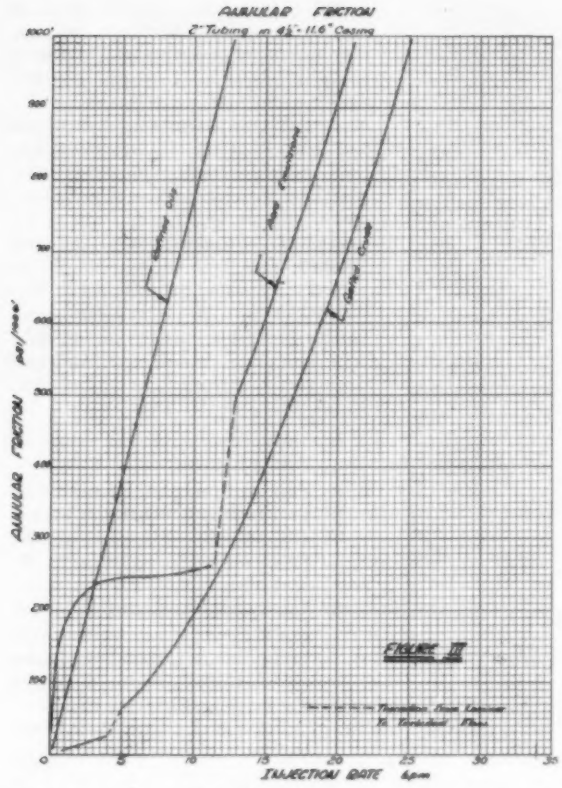


FIG. 3. **For 2-in. tubing in 4½-in., 11.6-lb casing,** here's annular friction loss when injecting at various rates for three frac fluids.

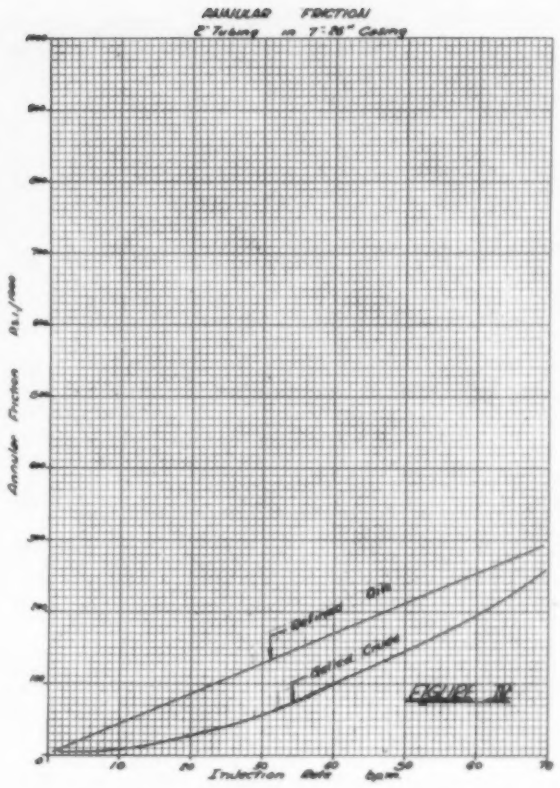


FIG. 4. **Annular friction loss** between 2-in. tubing in 7-in., 26-lb casing for various injection rates and three types of frac fluids.

casing are given in Fig. 1 through 4. Construction of these curves, basis of calculations and pertinent experimental data are presented in the appendix.

How to Calculate Surface Injection Pressure

The minimum surface pressure required to accomplish a desired injection rate can be determined by adding the bottom-hole injection pressure minus the hydrostatic head to the pressure drop due to friction. (Since the hydrostatic head of the fluid column decreases the required surface pressure, it is subtracted from the bottom-hole injection pressure as determined from Fig. 5 or experience.) The following formula can then be written:

$$P_s = P_f + (P_b - P_h)$$

Where:

P_s is the surface pressure,

P_f is the friction pressure,

P_b is the bottom-hole injection pressure,

P_h is the hydrostatic head.

P_f or friction loss can be determined for tubular goods (tubing or casing) from previous reports[1,2] or for annular strings by use of Fig. 1 through 4.

P_b or bottom-hole injection pressure can be obtained from Fig. 5, which is based on statistical field data from 385 wells, or from more reliable experience within the given area.

P_h or hydrostatic head is taken from Fig. 6.

The term $(P_b - P_h)$ may be defined as the formation injection pressure.

FIELD APPLICATIONS

There are many advantages to treating with the tubing in the well,[4] some of which are:

1. Eliminates pulling and running tubing.
2. Avoids necessity of a well kill after treatment.
3. Permits swabbing through the tubing.
4. Provides positive control of a high-pressure well.
5. Allows a variety of treatment procedure.

With the tubing in the well, the treatment can be performed down the tubing with the casing static, down the casing (annulus) with the tubing static or down both the tubing and the casing annulus.

The desired injection rate, the resulting friction pressure, the bottom-hole injection pressure, and the pipe strength combine to determine which of the three routes must be selected. The friction pressure plus the formation injection pressure combine to establish the surface treating pressure. The surface treating pressure, in turn, can be used to determine the minimum hydraulic horsepower required to fulfill the treatment specifications. For example consider the following case:

Depth — 4000 ft,

Fluid — gelled crude with 2 lb per gal sand (sp gr = 1.008),

Desired Injection Rate — 17 bbl per min,

Casing — 5½-in. – 14 lb with 2-in. EUE tubing,

Bottom-Hole Injection Pressure — 3500 psi.

Pressure Limitations of Casing — 3000 psi,

Hydrostatic Head — 1750 psi (Fig. 6).

The desired injection rate completely eliminates the possibility of treating down the tubing alone. There are two possible choices: Either perform the treatment down the annulus with tubing static or treat down both the tubing and the annulus.

1. **Down the Annulus With the Tubing Static:**

Annular friction at 17 bbl per min = 100 psi per 1000 ft.

Total annular friction = 400 psi.

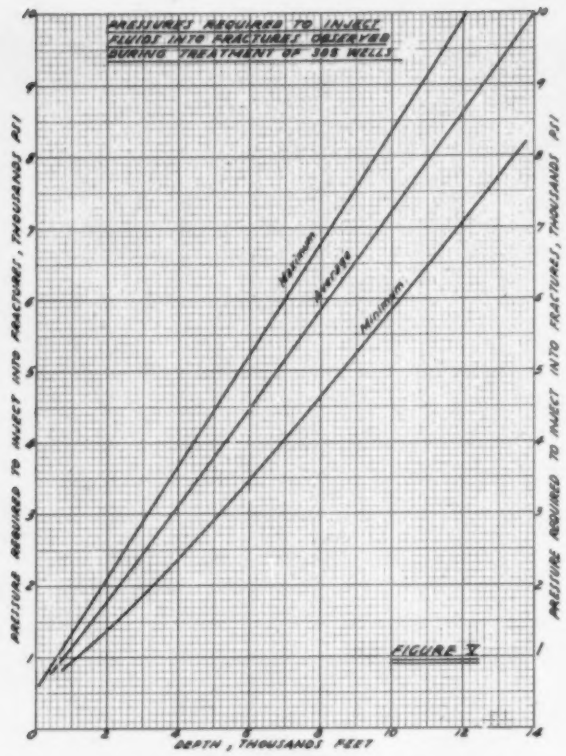

PRESSURES REQUIRED TO INJECT FLUIDS INTO FRACTURES OBSERVED DURING TREATMENT OF 385 WELLS
Maximum
Average
Minimum
FIGURE 5
PRESSURE REQUIRED TO INJECT INTO FRACTURES, THOUSANDS PSI
DEPTH, THOUSANDS FEET

FIG. 5. Required injection pressures for fracturing at various depths as observed during treatment of 385 wells.

Formation injection pressure — 1750 psi.
Surface treating pressure = 2150 psi.
Resulting surface pressure is within the casing limitations.
Next determine the hydraulic horsepower required.

$$HHP = \frac{17 \text{ bbl/min } (2150 \text{ psi})}{40.5} = 900.$$

2. **Down the Annulus and the Tubing:**
Tubing — assume 5 bbl per min.
Friction pressure = 520 psi per 1000 ft.
Total friction pressure = 2080 psi.
Formation injection pressure = 1750 psi.
Surface treating pressure = 3830.
The hydraulic horsepower required is:

$$HHP = \frac{(3830)\ (5)}{40.5} = 474.$$

Annulus:
Annular friction at 12 bbl per min=55 psi per 100 ft.
Total annular friction = 220 psi.
Formation injection pressure = 1750 psi.
Surface treating pressure = 1970 psi.
The hydraulic horsepower required is:

$$HHP = \frac{(1970)\ (12)}{40.5} = 585.$$

Total hydraulic horsepower = 1059.

It is obvious from this analysis that this treatment could more economically be performed down the annulus alone.

Should tubing be pulled? Another problem often arises as to whether or not the tubing should be removed from a well in order to facilitate the stimulation treatment. The deciding factors in this situation usually are:

1. Desired injection rate,
2. Resulting friction pressure,
3. Bottom-hole injection pressure,
4. Pipe strength.

For example, consider the following treatment.

Depth = 8000 ft.
Treating fluid = refined oil with 2 lb sand per gal.
Desired injection rate = 25 bbl per min.
Casing = 5½ in. — 17 lb with 2-in. EUE tubing.
Bottom-hole injection pressure = 5200 psi.
Pressure limitations of casing=4500 psi.

Can this treatment be performed as prescribed?

The first step is to calculate the pressure caused by the hydrostatic head based on a slurry specific gravity of 1.06 (Fig. 6) Then:

Hydrostatic Head = 460 psi per 1000 ft.

Total HH — 3680 psi.

The bottom-hole injection pressure minus the hydrostatic head indicates that portion of the surface treating pressure that is in excess of pipe friction.
That is: 5200 psi—3680 psi=1520 psi.

The total surface treating pressure is then the pipe friction plus this 1520 psi. The annular friction can be determined from Fig. 1.

Annular Friction = 420 psi per 1000 ft.

Surface treating pressure would be: 3360 psi + 1520 psi = 4880 psi.

This is greater than the casing pressure limitation; hence, the treatment could not be performed as desired. This leaves three possible alternatives:

1. Decrease the desired injection rate,
2. Pull the tubing and proceed with the treatment down the casing. (In which case fewer pumping units would be required to deliver the 25 bbl per min),
3. Change the fluid specifications to one that would develop less friction pressure such as lease crude or gelled lease crude. (Changing the treating fluid from refined oil to lease crude would allow this well to be treated with a surface treating pressure of about 3300 psi.)

These examples illustrate two of the more useful applications of annular friction. Although this method and the curves introduced are subject to a probable error of about ± 6 percent, they should prove to be a useful tool to the engineer designing well stimulation treatments.

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APPENDIX

How to Determine Annular Friction Loss

The subject of annular friction has long posed a problem. This article presents a method of calculating the annular friction and substantiates the method with field results. As a further aid to the engineer, a set of curves illustrating the relationship between the injection rates and the pressure losses is included.

The calculated values constituting these curves were determined by use of the equations:

$$\Delta P = 23.8 \frac{fQ^2Lp}{(D_1 + D_2)\left[(D_1^4 - D_2^4) - \frac{(D_1^2 - D_2^2)^2}{\text{Ln } D_1/D_2}\right]^{.1}} \quad . \quad . \quad 1$$

$$N_{Re} = 3.31 \times 10^4 \left[\frac{pQ}{(D_1 + D_2)\,U}\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 2$$

(Complete derivation available from author upon request.) The units and terms appearing in these equations are defined as follows:

D_1 = ID casing (in.)
L = Length tubing (ft)
p = Specific gravity
D_2 = OD tubing (in.)
Q = Injection rate (bbl per min)
U = Viscosity (cps)
f = Fanning friction factor
N_{Re} = Reynolds number
ΔP = friction pressure (psi)

The friction factor (f) is determined from the standard Reynolds number —Fanning friction factor graph where $f = 16/N_{Re}$ for laminar flow.[3]

The U factor in Equation 2 is determined from the relationship of the fluid viscosity to the rate of shear (expressed as a velocity) according to the equation[1,2]:

$$U_{act.} \frac{U_{meas.}}{V^m} \quad . \quad . \quad . \quad 3$$

Where: $U_{meas.}$ is the fluid viscosity measured at the desired temperature and at (or extrapolated to) a shear rate of 1 ft per sec, $U_{act.}$ is the apparent viscosity at the designated shear, V is the designated rate of shear, and m is the absolute slope of the $U_{meas.}$ vs. V curve.

For Newtonian fluids the slope factor (m) is zero. For gels and emulsions, the slope factor is negative. That is, viscosity decreases with increasing shear.

The correlation between annular friction values calculated by use of Equations 1 and 2 to those experimentally determined is illustrated by Table 1. The experimental values were determined from one of three methods:

1. A bottom-hole pressure measuring tool situated in the well during the treatment.
2. Simultaneous pressure gage readings taken from the static tubing and the annulus during the treatment.
3. The difference between the treating pressure and the instantaneous shut-down pressure.

The agreement between the calculated and "observed" friction values is obvious.

Fig. 1, 2, 3, and 4 depict the common annular flow situations. The different curves appearing on each of these figures will be discussed in order.

Gelled Lease Crude and Lease Crude:

Viscosity of the gelled lease crude decreases according to Equation 3. The gel used in the graphs had an initial Brookfield viscosity of 1550 cps (No. 1 spindle at 2 rpm). The viscosity decreased with increasing rate of shear by a slope factor of about –0.75. At an injection rate corresponding to a fluid velocity of 15 ft per sec, viscosity of the gelled crude is essentially that of the lease crude, that is, 10 cps. Hence, for all practical purposes the gelled crude and lease crude curves are identical.

The friction values indicated in Fig.

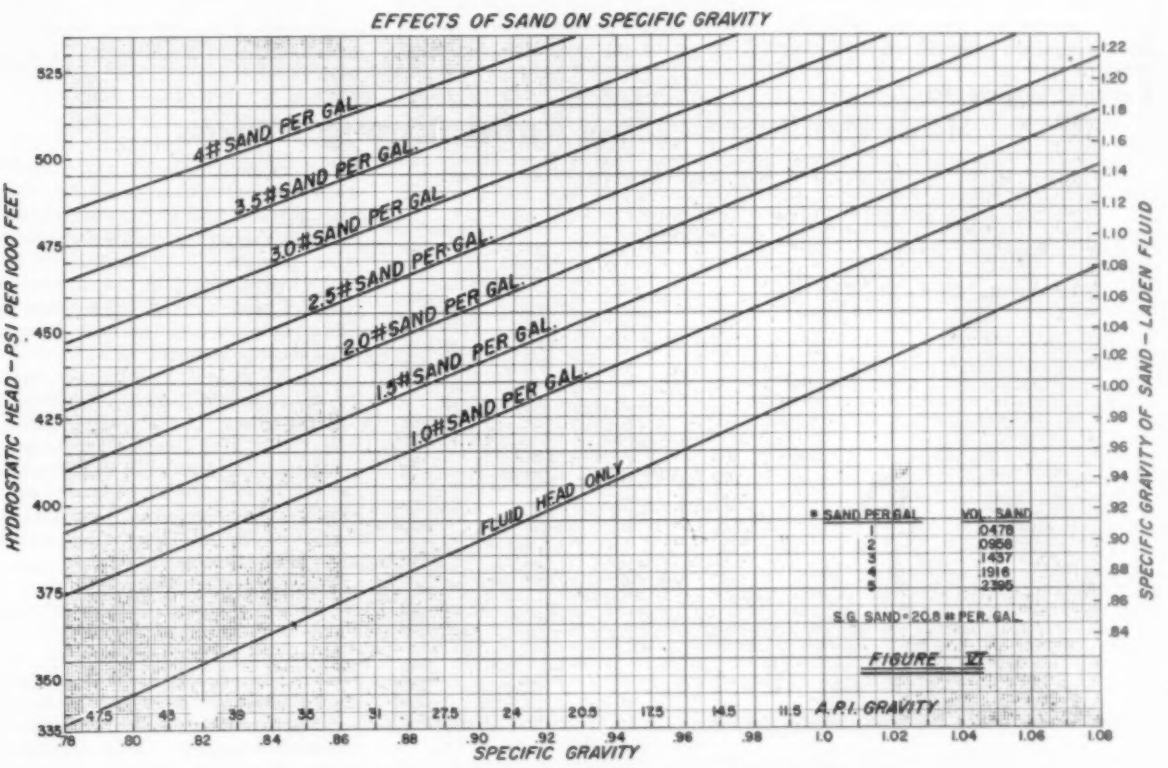

FIG. 6. **Effect of sand on specific gravity** of fracturing fluids. Hydrostatic head and specific gravity of sand-laden fluid are given.

TABLE 1. Correlation Between Calculated Annular Friction Values and Those Determined Experimentally.

p(gm/cc)	U(cp)	m	D_1(in.)	D_2(in.)	Q(bbl/min)	Depth (ft)	dP_{obs} (psi)	dP_{calc} (psi)	Percent error	Type Fluid
.763*	2*	0	5.0	2.375	12.5	5900	200	175	−12.5	Lease crude
.89*	5*	0	5.0	2.375	23.9	5900	925	885	− 4.5	Gelled crude 1lb/gal sand
.984	130	0	4.89	2.375	15.4	7500	1300	1300	0	Refined oil—1 lb/gal sand
1.02	130	0	5.0	2.375	21.0	4700	1600	1640	+ 2.5	Refined oil—1 ½lb/gal sand
1.14	130	0	5.0	2.375	13.0	3100	600	650	+ 8.5	Refined oil—3lb/gal sand
1.01	10	0	4.95	2.375	20.8	6880	1100	1000	− 9.0	Gelled crude—2lb/gal sand
1.09	10	0	4.95	2.375	24.7	7250	1600	1520	− 5.0	Gelled crude—3lb/gal sand

*These values were actually measured. The remaining values of the same parameters were estimated from experience.

1, 2, 3, and 4 are based on gelled crudes (or lease crude) containing 2 lb of sand per gal. Specific gravity of the sand-oil slurry was assumed to be 1.008 based on 35 API gravity crude plus the required increment for sand. For each pound of sand per gallon deviation from two, and 8 percent correction should be applied to the tabulated friction values. For example, if only 1 lb of sand per gal was used, the indicated friction pressure should be decreased by 8 percent; if 3 lb of sand per gal were used, the indicated friction pressure would be increased by 8 percent.

Acid Emulsions

The viscosity of emulsions also decreases with increasing shear according to Equation 3. The difference is that the initial viscosity and the slope factor of the emulsion are such that the apparent viscosity does not decrease to that of acid within the normal pumping rate range. This necessitates the use of Equation 3 in annular friction determinations involving emulsions.

The emulsion typified in Fig. 1, 2, and 3 had an initial Brookfield viscosity of 30,000 cps (No. 5 spindle at 2 rpm) with a slope factor of −0.85. A sand content of 2 lb per gal was once again assumed. The specific gravity of the sand slurry was 1.144. The same 8 percent sand correction factor applies.

Refined Oils

For all practical purposes, refined oils behave as Newtonian fluids, especially at temperatures of about 100 F or higher. In this event, as was previously mentioned, the slope factor is zero and the viscosity measured at any rate of shear is the true viscosity. At higher rates of shear (turbulent flow) refined oils exhibit a higher friction pressure than does either the gel or the emulsion. This is due to the lesser viscosity of the emulsions and gels at higher rates of shear.

The refined oil used in the annular friction curves had a viscosity of 130 centipoises. The sand ratio and correction factor is the same as that designated for the gels and emulsions. The specific gravity of oil-sand slurry was 1.062.

Gelled Water and Water

The curves for gelled water and water which do not appear on the annular friction graphs, would appear slightly below the curve for gelled crude.

Acknowledgment

The author wishes to express his appreciation to the various divisions of The Western Company for their assistance in the preparation of this paper and to the management of The Western Company for permission to publish this information.

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Survey points to . . .

High Drilling Success Ratio Among Majors

Analysis of Drilling Activity 1957

17 Major Oil Companies*	Net Wells Drilled — All Wells — Total	All Wells — Successful	Exploratory Wells — Total	Exploratory Wells — Successful	Success Ratios — All	Success Ratios — Exploratory
	(1)	(2)	(3)	(4)	(2)÷(1) (5)	(4)÷(3) (6)
1. Gulf Oil	1,754	1,464	208[2]	70[2]	83%	34%
2. Shell	1,274[2]	961[2]	269[2]	48[2]	75%	18%
3. Socony Mobil	882	747	40	10	85%	25%
4. Humble Oil & Ref.	867	648	169	47	75%	28%
5. Standard (Indiana)	841	624	195	59	74%	30%
6. Standard of Calif.	781	636	97	28	81%	29%
7. Cities Service	676[2]	542[2]	97[2]	29[2]	80%	30%
8. Continental Oil	511	393	83	23	77%	28%
9. Skelly	464	378	84[2]	26[2]	81%	31%
10. Sinclair Oil[1]	496	361	908	23	73%	21%
11. Sunray Mid-Continent	326	229	82	17	70%	21%
12. Phillips Petroleum	319	264	40	16	83%	40%
13. Union of Calif.	284	204	90	29	72%	32%
14. Ohio Oil	227	197	43[2]	13[2]	87%	30%
15. Tidewater	187	167	22	13	89%	59%
16. Pure Oil	182	125	43	19	69%	44%
17. Standard (Ohio)[1]	70	43	23	5	61%	22%
Total, 17 majors	10,141	7,983	1,693	475	79%	28%
Total, United States	53,838**	33,137**	14,707***	2,810***	62%	19%
17 majors as a percent of United States	19%	24%	12%	17%		
United States Total, Excluding 17 majors	43,697	25,154	13,014	2,335	58%	18%

*The following companies excluded because of lack of data: Texas Co., Atlantic Refining Co., and Sun Oil Co. Data for the 17 majors are from Annual Reports.

**Oil and Gas Journal, January 27, 1958.
***AAPG Bulletin.
[1] Includes some Canada.
[2] Gross.

Seventeen major oil companies had a higher overall drilling success rate than others in the industry last year, according to a study prepared by Boni, Watkins, Jason & Co., economic consultants. Success ratio for 17 companies was 79 percent for all wells drilled by these companies, as against 58 percent for all other companies.

The 17 majors, however, devoted a relatively smaller portion of their total drilling effort to exploratory drilling than did all other companies, the report indicates. Whereas some 30 percent of wells drilled by other companies were classified as exploratory, only 17 percent of the majors' wells were so classified.

Tidewater Top-Ranked

Shifts in company positions occurred between the firm's 1955 and 1957 surveys. Tidewater, which was tied with three other companies for sixth place in overall success ratios in 1955, moved into first place as the most successful of these companies in its drilling efforts, with an 89 percent success ratio (compared with 80 percent in 1955).

Shock absorber table, double elevators . . .

Taking Fatigue, 'Bite' From High Test Drill Pipe

No slips allowed on high tensile pipe by Phillips Petroleum Company on world's deepest well, other West Texas deep drilling operations

C. R. Graham
Assistant Editor

A SPECIALLY DESIGNED hydraulic shock absorber table and two sets of elevators are being used by Phillips Petroleum Company to reduce failures in high tensile strength drill pipe used in deep West Texas wells. The shock absorber cushions the impact when drill pipe connections are made and handling drill pipe coming out and going in the hole . . . and two sets of elevators replace conventional drill pipe slips to eliminate possible failures originating at the dog marks.

The unique arrangement for "kid glove" treatment of high tensile drill pipe is now used on three Phillips' drilling operations in West Texas. The first installment was made on the company's Rig. 27 drilling the No. 1-EE University, newly-crowned world's record depth holder. Immediate success prompted a second cushioning table and double elevators to be placed on Phillips' Rig 25, now drilling below 21,600 ft, also in Pecos County, Texas. A third test is in operation on a deep well being drilled for Phillips by Great Western Drilling Company.

Need for High Tensile Drill Pipe

Long strings of high tensile pipe are in use on all three wells. New grades of drill pipe (X-95, P-105, P-110) are now considered necessary to meet high tensile load requirements existing in deep drilling. Although the pipe is stronger, it is less ductile and therefore more prone to "shattering" tendencies.

The problem of finding means — other than slips — for handling high tensile pipe ceased to be an academic one for Phillips in January. At this time engineers traced an expensive drill pipe loss in a 21,397-ft well directly to the point of slip-segment contact. It was then that Phillips originated the impact-

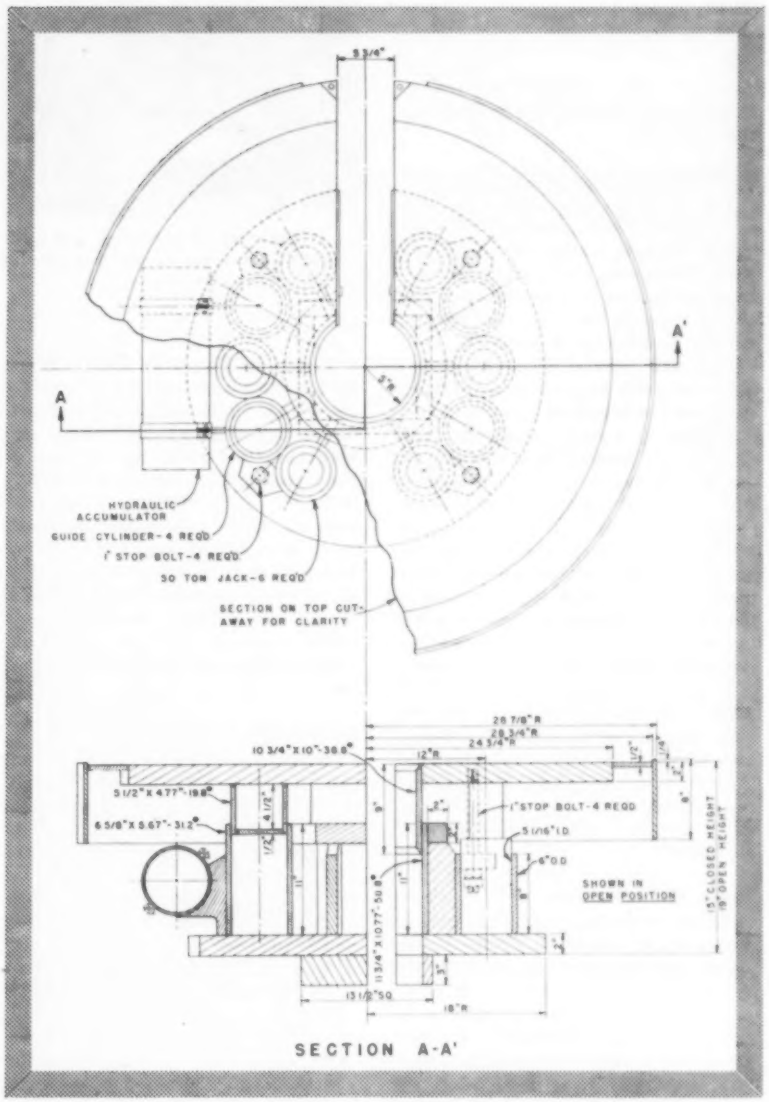
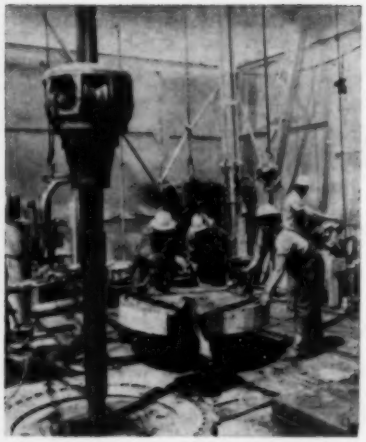


FIG. 1. **Schematic diagram** of hydraulic shock absorber table. Top view illustrates relative positions of guides and jacks. Note sturdy construction, seen in side view, necessary to handle the 150 ton shock load.



Shock absorber table is moved into place over the rotary table as the kelly joint is pulled up . . .

breaking table, designed to reduce fatigue, and a double set of elevators, to eliminate slips.

Operation

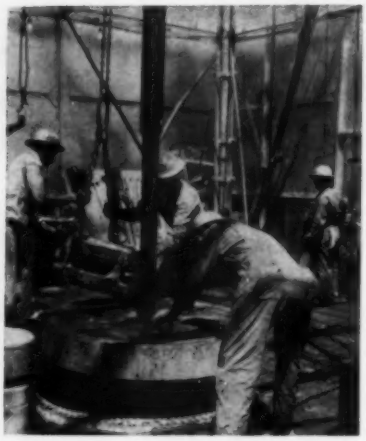
The shock absorber table is put into operation only when handling the high-tensile strength portion of the drilling string. Use of the table and double elevators is limited to this particular operation because of the time loss involved. Making up or breaking out a joint of drill pipe by this method takes 8 to 12 seconds longer than when using slips and a single set of elevators.

Phillips' drill pipe program for deep drilling in West Texas calls for a "mixed" string, beginning on bottom with Grade E pipe. This pipe meets specifications for drilling to about 15,000 ft. As the dead weight load increases, it becomes necessary to introduce the newer, high strength pipe at the top of the string. On the No. 1-EE University, for example, the company is running about 8000 ft of high tensile drill pipe. All connections and trips made with this pipe are made with the table in place over the rotary bushing and using two sets of elevators. None of this pipe has been touched by slips. Due to decrease in shock loading, life of this pipe has been prolonged immeasurably.

Table Construction

Weight of the four-mile string of drill pipe is about 300,000 lb. The hydraulic system was designed for dead weight load capacities up to 375,000 lb. Construction of the table was such as to complement the hydraulic requirements. The table itself weighs about 3650 lb. Basically it consists of two 2-in. thick steel slotted discs separated by six hydraulic jacks and four guides, (Fig. 1).

Top of the table is 57-in. in diameter. Purpose of the large table top area is for placement of both sets of elevators. Bottom of the table is 36-in. in diameter, onto which is welded 3-in. long seating guides fitting into the master bushing of the rotary table. For stability, four guides are constructed; these are made of 6⅝-in. and 5½-in. OD



. . . as first set of elevators are positioned on the table around top joint of high-strength pipe . . .

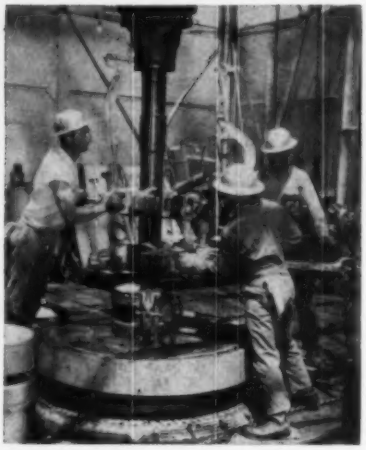
sections of casing pipe. The jacks are held in place by 6-in. OD pipe. The top and bottom sections of the table are joined together by four 1-in. stop bolts. Two 3-in. eyes are mounted on the table top for winch line handling. A 5¾-in. slot in the table permits the unit to be easily moved onto the rotary table and around the drilling string. Hole in the hydraulic table is 10-in. in diameter — about the same opening as in the rotary master bushing. A protective cover of steel plate is slid into place over the slot while the table is in use.

Hydraulic Circuitry

Absorbing drill pipe shock loads are the six 50-ton rig-type jacks. These are connected in series to a 1½-gal piston type accumulator precharged with nitrogen. The jacks have a 4-in. travel from unloaded to fully-loaded positions. Speed of this travel may be increased or decreased by restricting hydraulic flow back to the accumulator. This is accomplished by a ½-in. needle valve between the jack hookup and the accumulator. Hydraulic pressure is checked by a 0-5000 psi gage that is positioned near the accumulator. A safety valve is also provided and is set to release at a predetermined pressure, (Fig. 2).

The throttling valve may be adjusted for the hookload to be carried: The heavier the load, the more restriction on the throttling valve. The accumulator is recharged with nitrogen on location.

The hydraulic flow pattern is such that there is a uniform buildup of downstream pressure within the system. When the drill pipe load is first applied to the table, the downstream pressure within the jacks are low. This builds up as the pistons recede into their cases and push fluid back into the accumulator. The in-series hydraulic flow is designed to keep the table level. When fully loaded, the table will seat its 4-in. of travel in about 2 sec. The nitrogen in the accumulator, which is compressible, slows the fluid flow at an ascending rate. This flow movement results in good shock absorbing action of the entire table, thus eliminating shock



. . . and is broken out; kelly is set back; links are attached to elevators and first stand is pulled . . .

waves caused by normal seating of the drill pipe. This impact, shock action is responsible for normal drill pipe fatigue.

The in-series hydraulic flow permits uniform settling of the jacks, interconnected with ½-in. high-pressure flexible hose terminating in the accumulator.

The hydraulic system was designed for a maximum of 5000 psi working pressure in the rams. These rams have approximately 75.3 sq in. of area, which at 5000 psi permits approximately 375,000 lb load on the ram system. Structural and friction losses decrease the load capacity slightly. However, it is possible to pressure the system to 4250 psi and maintain a 300,000 lb load aim.

Double Elevators

The need for reduction of shock loading of high tensile drill pipe was satisfied by the hydraulic shock absorber table. The detrimental effect of slip segment "bites" on drill pipe was solved by implementing two sets of side-door type elevators.

Phillips considered several ideas and proposals before acting upon the accepted plan. Some thought was given to redesign of slips and master bushing; this, although feasible, was thought to be a problem requiring time, extensive engineering and expense, and would not lend itself for immediate solution to an existing problem involving pipe in the hole at the moment. Lift subs were proposed for each stand of drill pipe; this was discarded as too expensive. It was suggested that a sub be placed on the drill pipe; this too, was eliminated because of cost considerations.

Use of two sets of elevators seemed to be the most economical solution using existing equipment. Elevators chosen for the job were of the side-door type. Phillips adapted the use of side-door elevators because of their ability to spread a more uniform compressive load around the drill pipe.

. . . Not a solution to all high tensile pipe problems, but the biggest step so far.

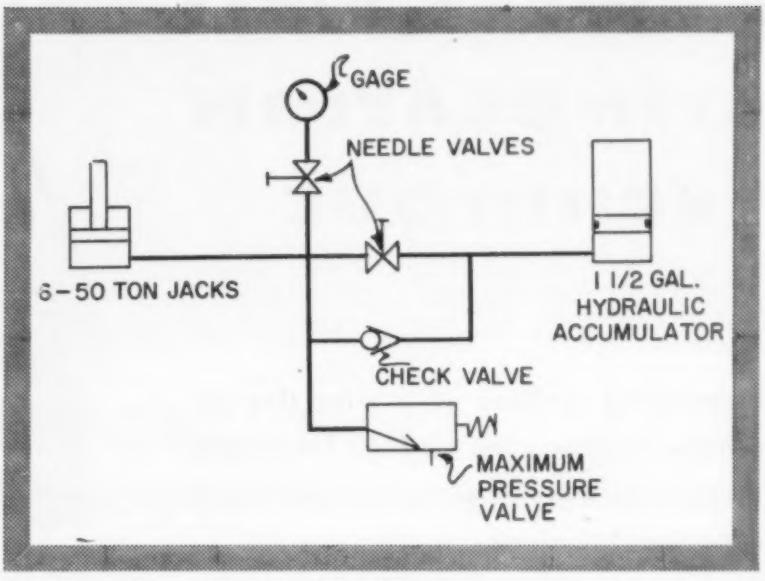
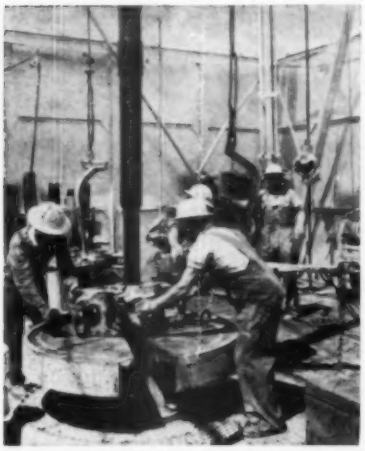


FIG. 2. **Hydraulic circuit** is designed for 5000 psi maximum operating pressure. In actual operation, the system is pressured to 4250 psi.



Second set of elevators are engaged and drill pipe weight rests on elevators and on cushioning table . . .

Modus Operandi

Use of the hydraulic table and double elevators was quickly adapted by Phillips' drilling crews. Few engineering changes were necessary after the first trial run. There have been no alterations, failures or incidents using the table or double elevators since they were first set on the rig floor several months ago.

The slip-less operation is simple. As the first joint is pulled out of the hole, using the first set of elevators, the hydraulic table is swung into place on the rotary table using an air-driven hoist. After the first stand is pulled, the second set of elevators are fastened around the pipe below the tool joint. When the first stand is racked, the traveling blocks return the elevators to the rim of the table, unfastened, and the links are transferred to the second set that are secured below the box joint of the second stand of the drill pipe. Rather that bolting the elevators and links, a break-type pin is used. These have proved both safe and fast. As the second stand is pulled, the original set of elevators, resting on the side of the shock absorbing table, are pulled into position and latched around the box joint of the top of the next stand, etc. Instead of the string resting in slips on the rotary table, they rest on the elevators, resting on the shock absorber table.

After string of high-strength pipe is racked, table is set back and air slips take over.

When the high tensile drill pipe is out of the hole, the table and extra set of elevators are moved away from the hole and air slips are moved over the rotary table to handle remaining Grade E drill pipe.

Means to an End

Phillips' engineers, who admit the shock absorber-double elevator system is both operable and economical, point out that it is only a step toward completely successful handling of the highly-necessary high-tensile strength grade pipe.

It is significant to note that the American Petroleum Institute, at its recent Mid-Continent district meeting in Oklahoma City, Oklahoma, established a study group on handling of high tensile strength drill pipe and tubing. ★ ★ ★

P 532.

Vibration fracturing is the . . .

NEWEST WELL STIMULATION TECHNIQUE

Controlled ignition of a wire line explosive charge creates high frequency vibrations which cause rock failure in a horizontal plane

Preparing to run vibration fracturing equipment in well to be treated. Complete assembly, measuring about 14 ft overall, consists of the following from bottom to top: Vibration charge, firing head, primacord sub, a contact sub, sinker bar, collar locator, and cable head.

Henry H. Mohaupt, *Petroleum Tool Research, Inc. Fort Worth, Texas* and **Herbert A. Metzger,** *Lane-Wells Company, Fort Worth, Texas*

A SPECIALLY DESIGNED explosive charge, run in on wire line and initiated under a fluid column, generates rapidly ocsillating pressure waves that cause consolidated formations to rupture along a horizontal plane. Of short duration, these high-frequency pressure impacts are followed almost immediately by a high-velocity surge of fluid into the starting fractures. The explosive charge is run under a minimum fluid head of about 600 ft of water (or oil equivalent) and the maximum fluid head at present is about 1200 ft of water. It is normally preceeded by a single 1½-in. diameter perforation and approximately 16 one-half-inch regular perforations in each zone to be stimulated to insure adequate communication from the formation into the well bore.

Called the PTR Vibro-Frac process by its developers, Petroleum Tool Research, Inc., of Fort Worth, Texas, this new well stimulation technique is under license to Lane-Wells Company.

Considerable research has gone into the development of this new stimulation idea which has been used with varying success on some 125 wells. Principal use to date has been in low pressure areas to precede conventional fracturing or acidizing techniques that normally could not be used alone without the risk of channelling, etc. Recent successes in water injection wells to improve water input rates point to another growing application.

It has also been used successfully in medium-pressure wells that could be killed with water or oil where the maximum head of fluid was equivalent to 1200 ft of water. New improvements to be discussed later will increase the fluid head permissible with this technique.

While there has been limited use on gas wells, there appears no reason why this technique would not be applicable in many wells to improve gas productivity . . . or, injectivity in the case of gas injection projects.

Tight sand formations have responded successfully. In tight limestones, the process has successfully created fractures in the desired zone and considerably reduced the acid treatment to achieve successful stimulation.

Overcomes fracturing hazards. With the exception of very thick producing formations, it is desirable in most wells to stimulate selectively individual or limited zones. Various procedures can be used to isolate these zones. These involve straddle packers, selective perforations, ball sealers, etc.

Success of these methods is predicated upon a good cement job . . . that the cement annulus and its interfaces with the casing and formation have a higher resistance to breakdown than the formation to be fractured. When this is not the case, a portion or a majority of the fracturing fluid injected into the well may take an undesirable path . . . breaking into adjacent barren or water or gas zones.

This new vibration fracturing process was designed to avoid fracturing into undesirable zones by channelling or uncontrolled fractures. This process subjects the formation to be stimulated to reasonably high frequency pressure oscillations. Peaks of these oscillations are in excess of the uniform pressure permissible with conventional hydraulic fracturing or acidizing techniques. While these pressure peaks are of considerably higher magnitude, their duration is short and the direction of the impulses are essentially horizontal . . . thereby minimizing harmful deforma-

tion of the steel casing or tendency to break the cement bond between the formation and the casing.

Preperforating Well

In field practice, the well casing is first perforated with a single high-capacity charge that opens a 1½-in. hole in each zone to be stimulated. This perforator, called the Vibro-Perforator, contains a powder charge that propels a disintegrating projectile at substantial velocity. Perforations of this 1½-in. projectile through 5½-in., N-80 casing into concrete have been measured at slightly over four inches. Other smaller perforations are used in addition, as it is essential that a minimum of five square inches of opening into the formation to be stimulated be provided.

What Happens Downhole

The stimulation charge, measuring 3¼-in. in diameter and about 5 ft long, is lowered opposite these perforations under a fluid head of oil, water, or special completion fluid. The special stimulation charge is carried in a magnesium housing that disintegrates upon activation. This activation is initiated in a manner which results in a controlled, oscillating pressure-time curve, shown in Fig. 1.

The formation immediately surrounding the charge is subjected to this oscillating pressure, receiving perhaps several thousand short impulses, as indicated in Fig. 2. Depending on the relative elasticity of the formation, and the inherent stresses that may be present, the strata are weakened momentarily by minute shifting. During this phase, the well fluid in the vicinity of the actuated charge is placed under increasing pressure.

Downhole pressure development. The increasing pressure results from the liberation of fluids generated by the charge. If there is adequate fluid column above the charge, the impedence of this column . . . or its resistance to upward movement during the very short duration of the explosion . . . will not be raised significantly.

Since the fluid is not blown out of the well, there is a substantial surge of pressure instantly following activation of the charge. This surge of fluid pressure is exerted on the already weakened strata under vibratory stresses through the large 1½-in. diameter perforation, and to a lesser extent through the smaller perforations in the immediate vicinity.

As the volume of fluid generated by the charge increases, raising the pressure, the combined effects cause failure of the strata and one or more fractures may result. It is believed that these fractures are propagated rapidly

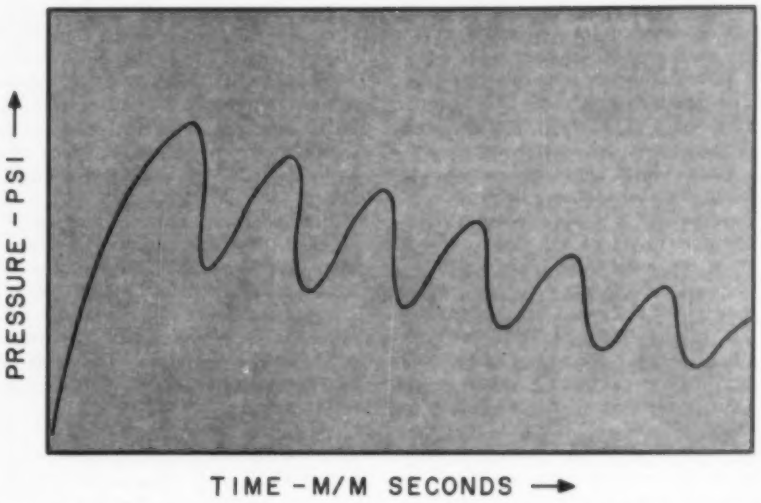


FIG. 1. **Schematic presentation of the pressure wave** generated by the new PTR Vibro-Shot. Note the gradual decrease in magnitude and amplitude of the pressure wave with time.

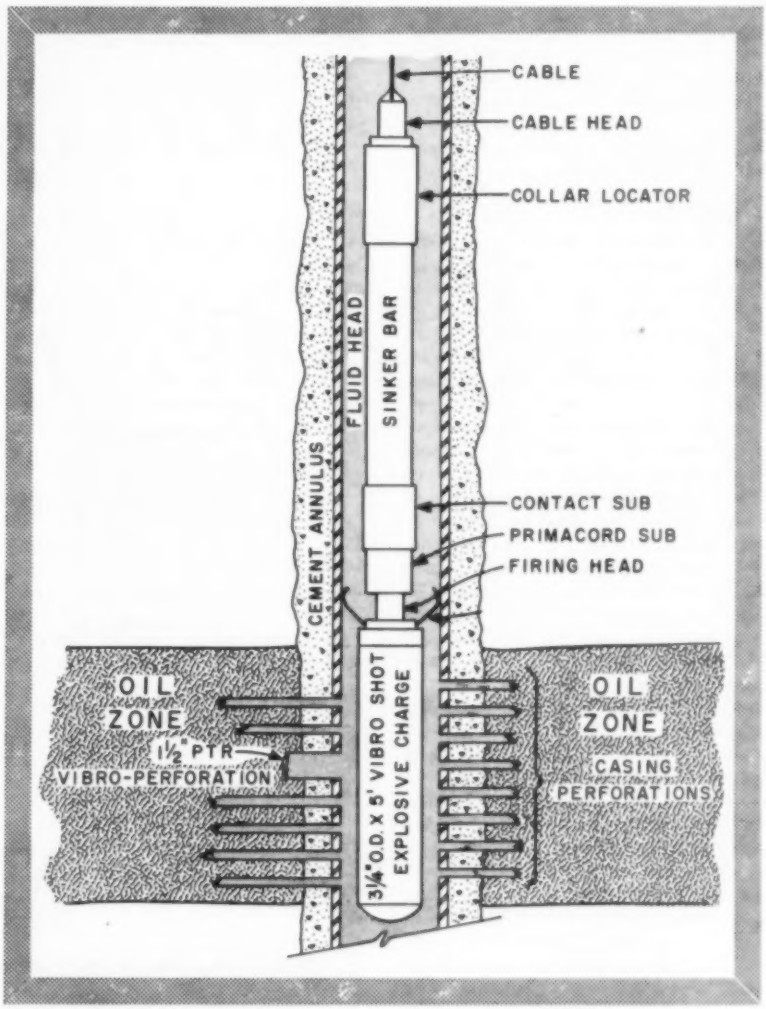


FIG. 2. **Downhole position** of charge assembly used in vibration fracturing. Note that perforated zone has been shot with the 1½-in. perforator and that the charge is positioned in the center of the zone to be stimulated.

in a lateral plane as the well fluid and fluids generated by the charge surge into the formation at rates in the order of several hundred barrels per minute. Statistical data on the effects of known weak zones in the vicinity of the zone to be fractured are being compiled.

Fluid column necessary. Behavior of the fluid column during detonation of the explosive was observed in a number of wells. Fluid columns of 200 ft of water were raised about 50 ft, whereas fluid columns of 600 ft of water or more showed a negligible reaction, raising only a few feet. Well conditions and the conditions of the well fluid such as gas cutting, influence the column reaction to the explosion to some effect. It is essential, however, that a sufficient fluid column to overcome the sudden pressure surge be placed above the charge.

The maximum fluid head (equivalent to about 1200 ft of water) is currently being increased by the development of a more dense and pressure-tight charge body. Improved magnesium alloys are being employed as the charge body which will enable it to withstand greater hydrostatic pressure. It is expected that in the near future, new charges will withstand a fluid column of 6000 ft of water or equivalent.

Application in the Field

This new well stimulation process is not a panacea for all problem wells. But, when properly used where applicable, its success ratio has been high. At the present time, it is necessary to study and evaluate all available well data, including radio-activity logs, electric logs, and core analysis. General knowledge of response to conventional stimulation methods by wells in a given area is extremely helpful in an evaluation of the new process in the same area or field. Formations such as the Lake Sand, the San Andres, the Glorietta, Navarro and the Devonian in Texas have been successfully treated. The Fortuna (sandstone), Brown dolomite in Oklahoma, and the Redfork and Arbuckle in Kansas also have shown good response.

A prerequisite for any successful stimulation treatment is that the formation contain commercial quantities of oil held in low permeable, porous sections, either in limestone, dolomites, or sandstones. Where core data are available, the normal treatment is to select two or more zones that meet the above requirements. A two to three-foot section is opened by shooting with the 1½-in. gun perforator and sufficient ½-in. perforations to obtain at least five square inches of area opening in the casing. A minimum of five square inches of total perforated area must exist in the zone to be stimulated.

The vibration-fracturing charge assembly is then lowered to this zone and activated. The formation is weakened in the perforated interval. From results obtained on numerous wells, it is believed this weakened zone consists of horizontal fractures which are easily extended by additional stimulation if necessary.

Following the explosion, the well is checked for debris and cleared if necessary. If the section treated was in limestone or dolomite, a 3000 to 5000-gal acid treatment is recommended if not more than two zones have been fractured by vibration. The well is swabbed in, if necessary, and placed on production.

When stimulating hard sand formations, additional treatment is not always necessary as very often an immediate rise in fluid level results. The well should then be tested, and if not producing satisfactorily, a light sand-frac treatment can be performed.

Experience to date indicates that resulting fractures by this new technique are horizontal. A number of wells have been stimulated near the water contact and later production remained water-free.

Need for study and planning. It cannot be emphasized too strongly before attempting well stimulation by this new method . . . that careful study and planning are essential. It is readily admitted that experience to date does not cover any great length of time nor a large number of wells, since this process has been in commercial use for one year only. However, sufficient data are available (125 wells) that well analyses can

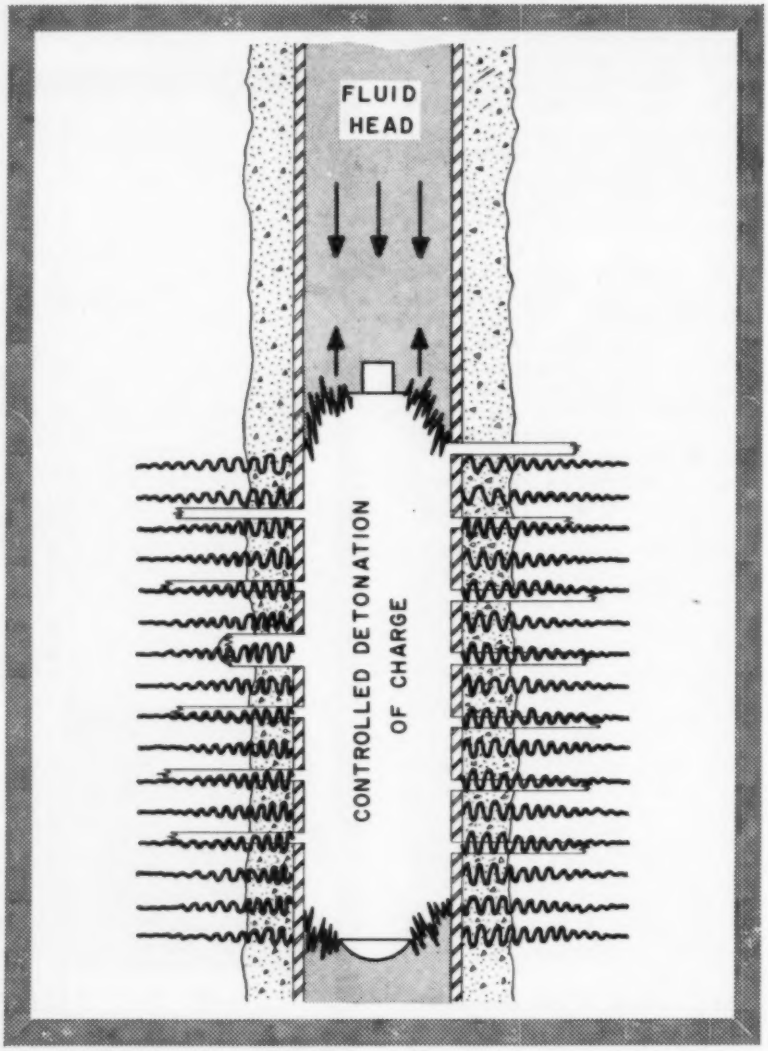


FIG. 3. **Distribution of oscillating pressure disturbances** from the controlled detonation into the reservoir rock. Note that each vibration is out of phase with the one above and below . . . which causes some minute shifting of rock particles, and rupture. Impedence of fluid head overcomes sudden force upward, forcing fluids radially out into weakened formation.

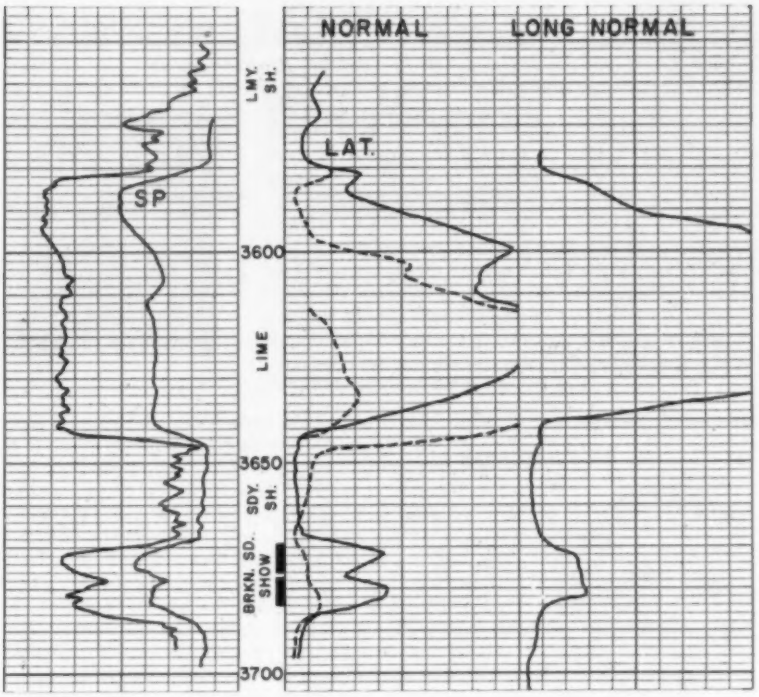


FIG. 4. **Electric log** of Bloomquist No. 1 well in Eastland County, Texas, where the vibration fracturing technique was used in its early field development. Black bars denote zones treated.

be made and recommendations given as to whether or not this type of stimulation would be successful.

Perforating the well. Perforating a well with the special 1½-in. perforator follows the same procedure for any normal shaped charge or bullet perforation job. It is run in on wire line with a collar locator on top of the single-barrel gun. Location of these 1½-in. perforations are determined from logs and collar log surveys. The projectile used is of special design to result in complete disintegration of the projectile. Surface tests of this one-shot 1½-in. perforator show that a good size hole is obtained through N-80 casing and extending more than four inches back into neat cement. Purpose of this 1½-in. diameter perforation in each zone to be treated is to insure adequate opened area for communication between the well bore and the formation to be treated.

Running the fracturing assembly. Running and activating the charge is quite similar to running a perforator. The complete down-hole assembly is shown schematically in Fig. 2. The upper part of the 5-ft magnesium body charge is equipped with centering guides. Immediately above this charge is a firing head which is connected into a primacord sub. The contact sub on the bottom of the sinker bar is adapted to the primacord sub by a special contact connection. Above the sinker bar is the collar locator and the cable head.

Since the charge and magnesium body are almost buoyant in water, and since the centering guides exert friction against the casing during descent, it is necessary to push the complete assembly down the well by means of a sinker bar. After activation of the charge, the entire assembly above the firing head is recovered.

NOTABLE CASE HISTORIES

North Central Texas

Fig. 4 is a log of the lower section of the G. A. Bloomquest No. 1 McClelland well which produces from the Lake Sand of Eastland County, Texas. In February of this year, the well was flowing 2 to 4 bbl per day. Gas production was about 62,000 cu ft per day, with no water. Prior to vibration fracing this well, it was killed with 50 bbl of oil, fluid level of which was at 2300 ft.

Two 1½-in. perforations were made — one at 3673 ft and a second at 3681 ft. The zone from 3670 to 3676 ft and from 3678 to 3684 ft had been perforated with six ½-in. holes per ft.

The new charge was centered at 3673 ft and activated. The well was bridged at 3670 ft which could not be dislodged by the sinker bar assembly. Fluid rise was 1000 ft the first hour after stimulation. Six joints of tubing were run in the hole before shutting down for the night. The well flowed 50 bbl in 14 hours during the night.

The next day, the well was again killed with 50 bbl of oil and the bridge was knocked to bottom by a sand pump. Tubing was run, but the well subsequently died and was shut in.

Two days later the well was turned into the tanks and flowed 50 bbl of oil and 160,000 cu ft of gas in 23 hours. The well flowed through an 11/16-in. choke while gas flowed through 7/16-in. orifice on outlet side of meter.

Orifice plate on the gas meter was increased to 1-in. so the flow line choke could be opened to 18/64-in. and retain the flow pens on the gas chart. Later that day, gas flow had increased to 350,000 cu ft per day and oil production was increasing. The following day, oil production dropped to 24 bbl in 24 hours and gas flow was maintained at 350,000 cu ft per day. Latest report in early April, the well was flowing 5 bbl of oil and 350,000 cu ft of gas daily.

In the San Andres of West Texas

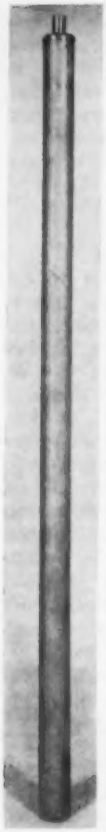
New well completion. In this original completion in the San Andres formation, 4½-in. casing was set through the pay zone and a radio-activity log was run. It was perforated from 4886 to 4878 ft with four shots per foot and from 4881.5 to 4882.5 ft with 10 shots per ft. One 1½-in. perforation was made at 4882 ft. Two charges were used, and since this well was treated in November 1957 when a early plastic charge body was used, the well bridged and had to be cleaned out by reverse circulation. Swab tests later produced from 43 bbl of oil, no water in 4 hours to 21 bbl of oil, no water, in a 6½-hour test.

The well was then treated with 500 gal of mud acid and 5000 gal of regular acid. It was swabbed in and placed on the pump. A three-day test indicated a productivity of 58 bbl of oil, no water per day. The well, when last reported, was pumping an average of 30 bbl of oil and a slight trace of water daily.

New well completion. This well was completed in January 1958, and 4½-in. casing was set through the San Andres pay zone. It was radioactivity logged and perforated with four shots per foot in the following two 1-ft zones: 4853 to 4854 ft, and 4863 to 4864 ft. A 1½-in. perforation was made in each zone. Two fracturing charges were used in each zone. The first charge was housed in an aluminum alloy body. Although it bridged, it was easily pushed to bottom with the sinker bar assembly. The remaining three charges were housed in the earlier plastic bodies and bridged, and had to be cleaned out.

The well would not flow, and was treated with 500 gal of mud acid and 5000 gal of standard acid. Swab tests produced 30 bbl of oil and a slight trace of water. The well is currently pumping 38 bbl of oil with a slight amount of water.

Old well. Originally completed in November 1957, with 5½-in. casing set through the San Andres pay zone, this well was radio-activity logged and jet perforated with 4 shots per ft from 4870 to 4904 ft. It was acidized and tested 5 bbl of fluid daily, 20 percent of which was water. One month later, production declined to 10 bbl per day and water increased to 180 bbl daily.



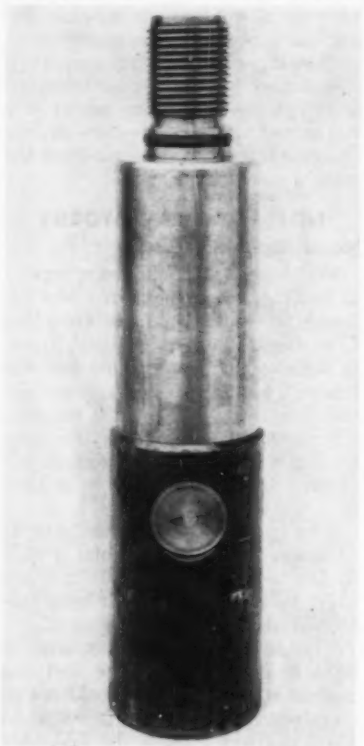
Explosive charge used in vibration fracturing treatments. Measuring 5 ft long and 3¼ in. OD, outside body is made of forged magnesium that disintegrates when charge is activated.

Perforated interval was squeeze cemented and gun perforated from 4877 to 4879 ft and from 4896 to 4998 ft with 4 shots per ft. One 1½-in. perforation was made in each zone. One vibration charge equipped with the new shattering magnesium body was used in each zone. The well did not bridge. Well was treated with 500 gal mud acid and 5000 gal of regular acid. The formation broke down at 1800 psi. Normal breakdown pressure in this area is from 2800 to 3300 psi.

The well was swabbed down, lowering fluid level to 800 ft. Twelve hours later, fluid level rose to 1800 ft. Subsequent swabbing brought in 50 bbl of oil per day. Present production is 60 to 70 bbl of oil per day with only a trace of water.

Old well. Another well originally completed in November 1957, with 5½-in. casing was set through the San Andres pay zone. Two zones were jet perforated. The upper zone measured 40 ft; the lower zone, 10 ft. Distance from bottom of top zone to top of lower zone was 10 ft. The well was treated with 500 gal of mud acid, 3000 gal of regular acid and 10,000 gal of fracture fluid. Original potential was unavailable. The well produced 97 percent water until February 1958, with no depletion of the water.

Perforations were tested and communication between zones was established. The lower zone was squeezed off. The upper 40-ft zone was shot with the 1½-in. perforator and two vibration fracturing charges were activated in the approximate center of the 40-ft zone. There was no bridging of the new magnesium charges. The well was reacidized with 3000 gal of regular acid. Present production is 40 bbl of oil daily with slightly more water than adjacent wells.



Single shot 1½-in. gun perforator used to insure adequate casing opening into zone to be stimulated by vibration fracturing.

Horizons Broaden with Use

Although actual field experience has been somewhat limited to date (125 wells treated), experience does indicate a number of useful applications for this new well stimulation technique. Also, this same field experience has clearly indicated some limitations. A number of successful jobs to increase water input rates for water injection point to increased applications where conditions permit.

Although most of the wells treated so far have served to condition wells for conventional fracturing or acidizing, it is known that in a number of well conditions, the new technique alone does provide the increased production rates desired.

Research and development continue, and although many refinements have already been made, additional field experience will help improve the efficiency and application of vibration fracturing. ★ ★ ★

THE AUTHORS

Henry H. Mohaupt *is president of Petroleum Tool Research, Incorporated at Fort Worth, Texas, and the developer of the vibration fracturing process. A native of Switzerland, he was educated in Zurich, and graduated from the Industrial College and Minerva Institute. His early research in explosives led to the development of the modern "lined shaped charge." World War II spurred the interest by both the French and U. S. military in the shaped charge and Mohaupt came to this country and applied the principle to a number of important U. S. military weapons, among which was the famous "Bazooka." In 1946, he assigned the commercial rights of the jet charge to Welex Jet Services and became the company's vice president in charge of research and development. In this capacity he adapted the shaped charges for well perforating. He formed his own company, Petroleum Tool Research, Incorporated, in 1954.*

Herbert A. Metzger *is a division sales engineer for Lane-Wells Company in Fort Worth, Texas, where for the past year he has coordinated the company's efforts in the development of the Vibro-Frac method of well stimulation. A native of Louisiana, he was graduated from the Louisiana State University at Baton Rouge with a BS degree in petroleum engineering in 1935 and shortly thereafter joined the Minerals Division of the Louisiana State Conservation Department as a field petroleum engineer. He was district engineer at Lake Charles and in 1940 made district manager of that area. For six months in 1941 he worked for Stanolind Oil and Gas Company (now Pan American Petroleum) in Tulsa as an evaluation and reservoir engineer. From the fall of 1941 until May 1946, he served in the U. S. Army Corp of Engineers supervising construction of air bases throughout the south. In November 1946, he joined Lane-Wells as district sales engineer in South Louisiana and in 1950 was transferred to Dallas, Texas, as division sales engineer. He was moved to Fort Worth in 1953.*

Creative Thinking Added to Southwest Executive Program

University of Houston limits registration for 6 weeks course to 24 . . . gives it three times a year

D. A. Stonebarger

Enrollees in training course to improve managerial skills.

Beginning October 13, 24 middle-to-top management personnel will converge on the University of Houston campus at Houston, Texas, and participate in the 11th session of the Southwest Executive Development Program. Texas Manufacturers Association has joined the University this year as co-sponsor of the program.

Primary objectives of the program are largely reflected in the following:

1. To aid each participant in developing a well-rounded philosophy of management and to improve his ability to think for himself and make important managerial decisions.
2. To increase the participant's understanding of and ability to deal with the interpersonal relationships of business organizations.
3. To create an organization-wide viewpoint and increase the participant's capacity to comprehend and deal with the broad, complex problems of company-wide management.

To meet these goals the University of Houston's Management Development Center has developed a curriculum consisting of 11 primary areas as follows: Managerial Organization and Control, Marketing, Production and Marketing Cost Analysis, Business Finance, Human Relations, Business and Community Relations, Communication and Training, Executive Action, Creative Thinking, Labor Relations, and a class to improve the participant's reading and report writing abilities. Creative Thinking and Business Finance were added this year.

Special sessions and field trips through industrial plants of the Southwest will supplement and complement the basic curriculum.

As important as the curriculum content, is the manner in which the course content is presented. Very little of the course involves instruction of the usual classroom lecture type. Rather, primary emphasis is given such techniques as the case method, role-playing, panels, conferences, visual aids, and personal consultation. Rather than learning almost entirely from the experiences of the instructor, the "students" grow through an interchange of their own experiences and views. The primary function of the instructor is thus to stimulate the thoughts and ideas of the participants.

In addition to several outstanding members of the University of Houston's College of Business Administration who participate as conference leaders in these programs, heavy reliance is placed on businessmen and leading educators from all sections of the United States.

Visiting faculty has included: Professor Lawrence L. Bethel, president, Fashion Institute of Technology; Richard Crow, director of personnel development, Continental Oil; Professor Keith Davis, department of management, Indiana University; Professor Ralph C. Davis, department of business organization, Ohio State University; Professor Walter L. Daykin, department of labor and management, University of Iowa; Professor Harvey W. Huegy, chairman, department of marketing, University of Illinois; Val Jean McCoy, public relations manager, Shell Oil; Edwin Morris, assistant director of industrial relations, Hughes Tool Company; Hubert L. Smith, vice president, Standard Oil of Texas; Professor John Mee, chairman, Department of Management, University of Indiana, Professor Michael Jucius, Ohio State University, Professor Eli Shapiro, Massachusetts Institute of Technology, and Franklin S. Atwater, works manager for Fafnir Bearing Company.

Enrollees of the program's preceeding sessions have represented a wide variety of industries, and all sections of the United States have been represented, as well as several foreign countries.

Enrollment for each session is limited to 24 executives. Companies desiring to enroll personnel in the program have complete discretion in selecting their nominees, but it is suggested that consideration be given those individuals occupying middle-management positions and above who have demonstrated the personal capacity and competency to advance in the company's organization. Each organization is limited to two enrollments for each session.

Popularity of the program is probably best reflected in the fact that participation demand has necessitated offering three programs each year. At this writing some organizations have made participant reservations for more than one year hence.

These sessions, all for six weeks, begin the second Monday in February, the first Monday in June, and the second Monday in October.

The sessions include five days of class meetings each week, with seven hours of instruction scheduled between 8:30 and 4:30 p.m. All classes are conducted in air conditioned buildings on the University of Houston campus. The new Center is patterned after the Harvard structure. Conferees will be seated on a tri-level seating arrangement so each participant will have full view of the conference leader. There are also a beautiful library, two seminar rooms, and a coffee bar. This new facility will be one of the best centers of this type in the United States.

Tuition for the course is $1000; it includes food, lodging, and all required instructional materials. Further information or registration details may be obtained by contacting Dr. D. A. Stonebarger, Director, Management Development Center, University of Houston, Houston 4, Texas. ★ ★ ★

Promising method of . . .

PERMEABILITY LOG DETERMINATION

Equation permits calculation of single phase liquid permeability as a function of depth, where porosity and saturation data are known

S. T. Yuster
Professor of Engineering
University of California
Los Angeles, California
and
A. S. Odeh
Associate in Engineering
University of California
Los Angeles, California

THE NEED FOR DEVELOPING a permeability log is realized in all segments of the petroleum industry. With this purpose in mind, equations have been derived which permit the calculation of permeability as a function of depth, thus leading eventually to a permeability log.

In formulating these equations, empirically determined relationships as well as analysis which was based on idealized system were used.

The equations indicate that if the permeability were known at a certain depth — from laboratory measurement — then taking that depth as the reference depth, permeabilities at any other depth could be calculated provided porosity and saturation data are available. Porosity and saturation data which could be obtained either from electric logs or from laboratory measurement could be fed into a computer resulting in a permeability log.

If the permeability were not known at any point then a permeability log could be calculated showing the relative magnitude of permeabilities as referred to a permeability of value unity at any reference datum. The absolute values of the permeabilities are then obtained when the permeability is known at any point. On the other hand if permeability versus depth were known then the equations allow the calculations of saturation as a function of depth.

Field Cases

Calculations were performed for two field cases and calculated permeabilities were compared with laboratory measured values. Results indicate a good qualitative and a fair quantitative agreement between the calculated and measured values.

The field cases were analyzed where permeability, porosity, saturation versus depth data were available. Calculated values of permeability as a function of depth were compared with laboratory measured values as shown in Fig. 1 and 2. In Fig. 3 and 4 the calculated values of saturation using the laboratory measured values of permeability are compared with the laboratory measured values.

The results in general are promising. Saturation versus depth results are good both qualitatively and quantitatively. Permeability versus depth graph show a good qualitative agreement beween the calculated and measured values.

Mathematical Derivation

From mercury injection capillary pressure curves it was found that if log P_c is plotted versus log S_w the data fell on a straight line with an intercept of P_c^* (the displacement pressure) at $S_w = 100$, and an exponent of 2.0-2.5.

Therefore

$$S_w = \left(\frac{P_c^*}{P_c}\right)^{\frac{1}{m}}, \quad P_c = \Delta \rho \, gh \text{ where } \rho \text{ is the density}$$

therefore

$$S_w = \left(\frac{h^*}{h}\right)^{\frac{1}{m}}.$$

$$\text{where } h^* = \frac{2\sigma \cos\Theta}{r^* \Delta \rho \, g}$$

From consideration of Darcy's law and Poiseuille's law one can write $r^* = 8.85 \times 10^{-6} \sqrt{\frac{k}{\phi}}$ where r^* (the radius of the equivalent circular capillary) is in cm; k (the single phase liquid permeability) is in millidarcys; and ϕ is the fractional porosity. Substituting to get

$$S_w = \left[\frac{2\sigma \cos\Theta}{8.85 \times 10^{-6} \Delta \rho \, gh}\sqrt{\frac{\phi}{k}}\right]^{\frac{1}{m}}$$

If m is assumed to be 2 then

$$S_w^2 = \frac{2\sigma \cos\Theta}{8.85 \times 10^{-6} \Delta \rho \, gh}\sqrt{\frac{\phi}{k}}, \text{ and}$$

$$h = \frac{2\sigma \cos\Theta}{8.85 \times 10^{-6} \Delta \rho \, g}\frac{1}{S_w^2}\sqrt{\frac{\phi}{k}} = \frac{c}{S_w^2}\sqrt{\frac{\phi}{k}} \text{ where}$$

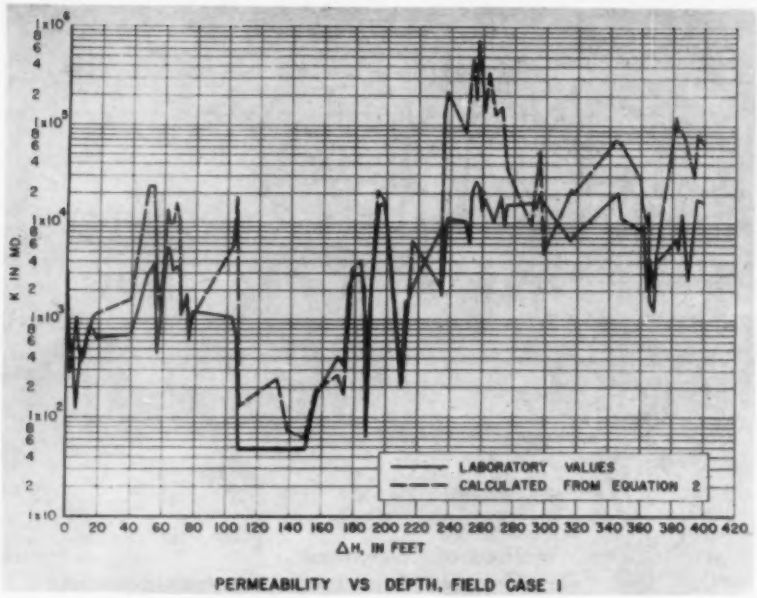
$$c \text{ is a constant} = \frac{2\sigma \cos\Theta}{\Delta \rho \, g \times 8.85 \times 10^{-6}}$$

$$h_1 = \frac{c}{S_{1w}^2}\sqrt{\frac{\phi_1}{k_1}}$$

$$h_2 = \frac{c}{S_{2w}^2}\sqrt{\frac{\phi_2}{k_2}}$$

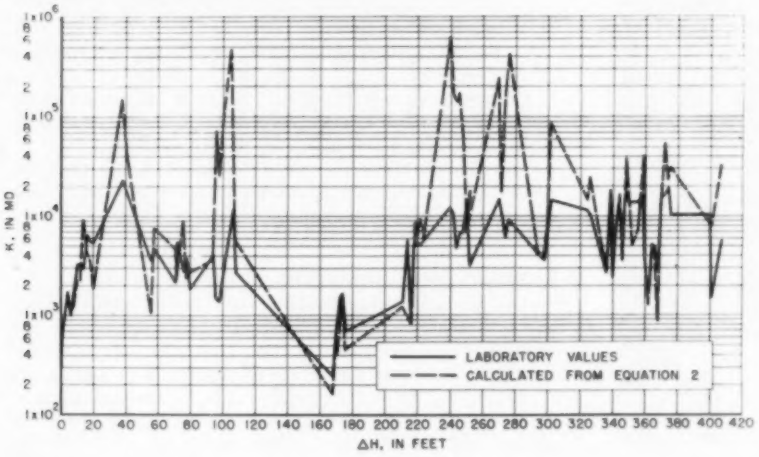
$$h_2 - h_1 = \Delta h = c\left[\frac{1}{S_{2w}^2}\sqrt{\frac{\phi_2}{k_2}} - \frac{1}{S_{1w}^2}\sqrt{\frac{\phi_1}{k_1}}\right]$$

$$\frac{1}{S_w^2}\sqrt{\frac{\phi}{k}} = \frac{1}{S_{1w}^2}\sqrt{\frac{\phi_1}{k_1}} + \frac{\Delta h}{c} \quad . \quad . \quad . \quad . \quad (1)$$



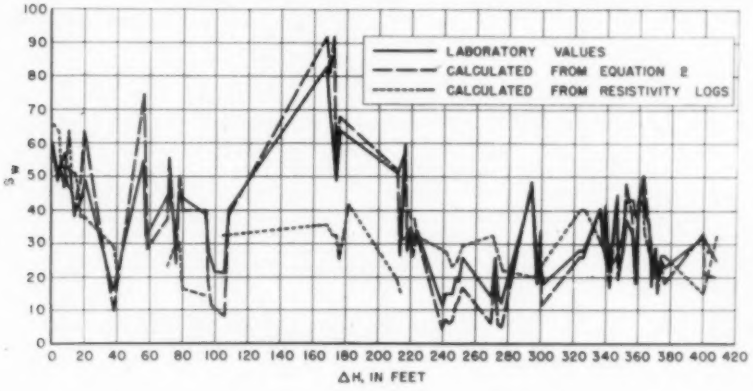
PERMEABILITY VS DEPTH, FIELD CASE 1

FIG. 1. **Permeability versus depth** curves compare laboratory measured values with calculated values of field case No. 1.



PERMEABILITY VS DEPTH, FIELD CASE 2

FIG. 2. **Calculated values** in field case No. 2 are compared with laboratory measured values.



SATURATION VS DEPTH, FIELD CASE 2

FIG. 3. **Saturation values,** field case No. 2, are compared with laboratory measured values.

The Authors

Aziz S. Odeh *received a BS degree in petroleum engineering in 1951 from University of California, Berkeley, and an MS degree in engineering in 1953 from the University of California, Los Angeles. From February 1953 until September 1956 he was employed by Magnolia Petroleum Company as a research engineer in their research laboratories in Dallas, Texas. At the present time he holds the rank of associate in engineering at the University of California, Los Angeles, while completing the requirements for a PhD degree in engineering.*

Samuel T. Yuster *received his BS degree in June 1926 from North Dakota State College, and his PhD degree in petroleum engineering in March 1934 from the University of Minnesota. Dr. Yuster has served as professor of petroleum engineering and chief of the division of petroleum engineering at the Pennsylvania State College from 1934 to 1949, and professor in the department of engineering at the University of California, Los Angeles, since June 1949. He has been active in directing and administering graduate work in this department as well as considerable research and consulting for oil and gas companies and a large chemical company.*

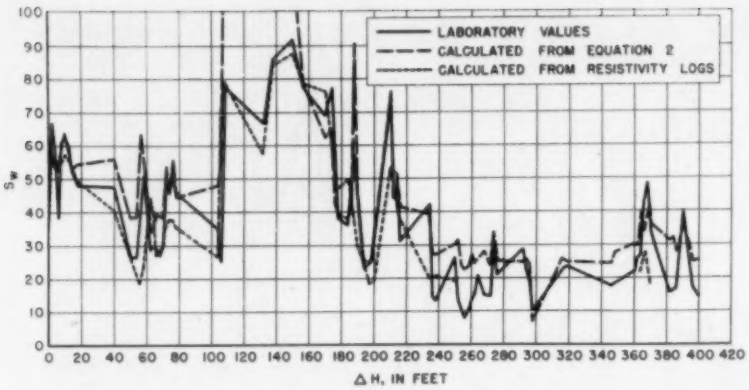


FIG. 4. **Calculated values** of saturation using the laboratory measured values of permeability are compared with the laboratory measured values, field case No. 1.

SATURATION VS DEPTH, FIELD CASE I

Therefore, if the values of water saturation, permeability and porosity were known at a point in the reservoir Equation 1 allows the calculation of $\frac{1}{S_w^2}\sqrt{\frac{\phi}{k}}$ at any other point. Thus, if any two of the variables S_w, ϕ and k were known as a function of h, then the third variable as a function of h could be calculated from the above equation.

In Equation 1, $c = \frac{2\sigma \cos\Theta \times 10^6}{8.85\,\Delta\rho\, g}$ is a very large value compared to Δh. One thus expects a very small variation in the value of $\frac{1}{S_w^2}\sqrt{\frac{\phi}{k}}$ as a function of depth. This is borne out in Fig. 5. Thus, as an approximation one can write

$$\frac{1}{S_w^2}\sqrt{\frac{\phi}{k}} = \text{constant} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Equation 2 is the fundamental equation that is to be used for calculation.

Both equations were derived with the assumption that capillary continuity exists, i.e., there are no impervious streaks, the sand texture does not change too drastically in the well and that true capillary equilibrium has been established in the reservoir over geological time.

Method of Calculation

When ϕ and S_w are know as a function of position and k is known for a few points:

a. Calculate $\frac{1}{S_w^2}\sqrt{\frac{\phi}{k}}$ for the points where k is known and take the average.
b. From this average, ϕ and S_w calculate k as a function of position.

The same procedure applies if ϕ and k are known or S_w and k are known as a function of position and one wishes to find S_w for the first case and ϕ for the second case.

This analysis indicates that a computer circuit could be established into which S_w and ϕ are fed as a function of position resulting in permeability values as a function of position, i.e., in a permeability log.

Summary and Conclusion

An approximate equation has been derived relating ϕ, S_w, and k. If any two of these three variables were known as a function of position, the equation allows the calculation of the third variable as a function of position. Fig. 1, 2, 3 and 4 indicate a good qualitative and a fair quantitative agreement between calculated values and laboratory measured values. Although the results are promising, it is believed that additional investigation on actual field data is warranted before the merit of this method is decided upon. * * *

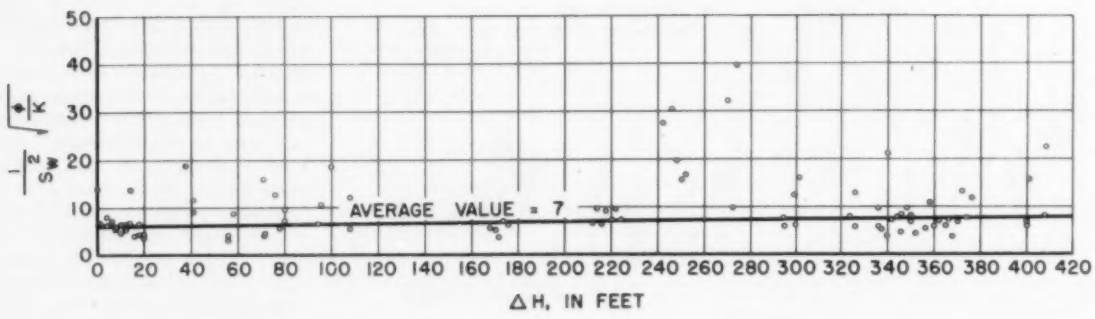
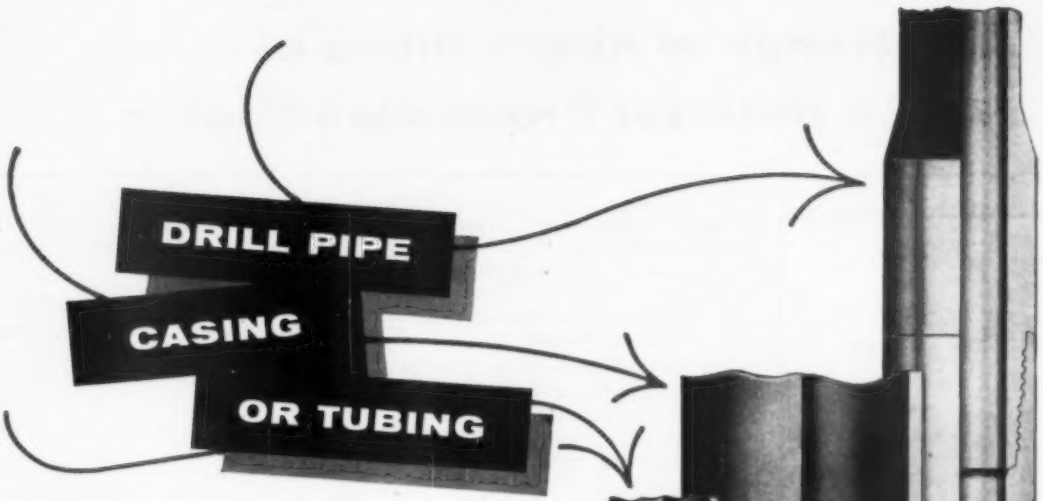


FIG. 5. **Small variations** in the value of the equation as a function of depth are illustrated here.

$\frac{1}{S_w^2}\sqrt{\frac{\phi}{K}}$ VS DEPTH



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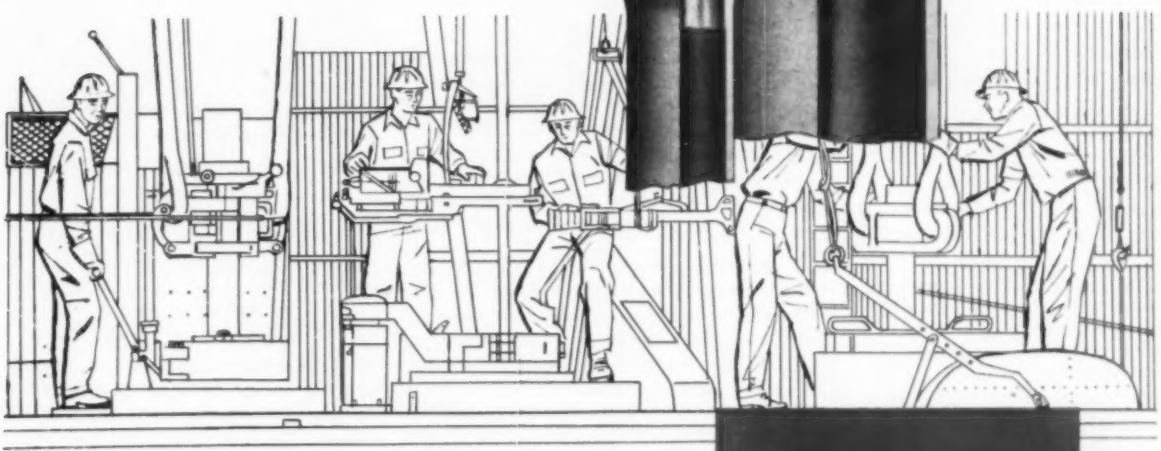

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"Universal" Aptly Describes Range of Applications of BAKER Retainer Production Packer

Baker Retainer Production Packer
Product No. 415-D

Baker Locator Tubing Seal Assembly
Product No. 442-E2

ADVANTAGES of the Baker Retainer Production Packer:

1. *Forms positive, leak-proof pack-off against any pressure differential from either above or below the packer that is safe for the casing.*

2. *Pack-off achieved without excessive set-down tubing weight, or tubing in tension.*

3. *Permits tubing string to be anchored to the packer, released from the packer, or completely removed from the packer, all at the discretion of the operator.*

4. *Complete removal of the tubing string from the packer will not disturb the isolation of the zone below the packer, provided the pressure differential is from below the packer.*

5. *Pack-off remains leak-proof under conditions of high temperature, even under pressure differentials that exceed the safety limits of the casing.*

6. *Can be set on wire line, tubing or drill pipe.*

In practically every production application the Baker Retainer Production Packer has earned the designation "Universal" Type; and it appears also to be the answer to many future production problems.

The range of applications is further broadened by its ability to hold high pressures from above or below—at record or shallow depths—even under temperatures in excess of 300 degrees Fahrenheit.

Because it can also be used successfully as a squeeze tool, it is ideal for testing, acidizing, formation fracturing, squeeze cementing, and other operations required in the completion or work-over phases of a well.

The following actual field records of general production, as well as supplemental applications of this "Universal" Type Packer may indicate a solution to your well problems:

PRODUCTION APPLICATIONS

Single-Zone Production—More Baker Retainer Production Packers are used for single-zone production than for any other application—proof of their increasing and widespread usage in a field previously dominated by retrievable type packers.

Dual-Zone, Single-Packer Application—The majority of dual-zone applications of the Baker Packer are single-packer, dual-zone installations. Because of its remarkable ability to maintain the absolute separation of two zones, this packer is widely known and accepted as the ideal dual-zone packer.

Dual-Zone Production (Baker Selective Hook-Up), Two-Packer Installation—This efficient hook-up enables the operator to produce (pump or flow), treat (formation fracture, acidize, etc.), or test either zone selectively through the tubing, while simultaneously producing the remaining zone through the annulus. The switch in flow, or selection of a zone for treatment, is accomplished at the discretion of the operator, using an instrument line.

Permanent-Type Well Completions—Long recognized as the world's most permanent production packer, the Baker Retainer Production Packer was accepted early in the development of this new completion idea as OUTSTANDINGLY FIRST for Permanent-Type Well Completions.

Parallel Tubing Installations—When a *single* packer is used, each tubing string can be run or pulled independently of the other, and by using a special Anchor and a Latching Sub, the short string can readily be anchored to the long string.

When *two* packers are used, each string is run or pulled separately, however, the long string must be *run* first, and the short string *pulled* first. Either the single-packer or the two-packer installation features a full opening to the lower zone for use of all permanent completion-type tools.

Off-Shore Installations—The Baker Packer is used in conjunction with a storm choke to prevent loss of production due to accidental damage to surface connections of off-shore installations. Permanence, plus the ability of the packer to hold mud weight above the packer are additional factors that recommend its use in this application.

SUPPLEMENTAL APPLICATIONS

In addition to its use in practically every type of production application, the Baker Retainer Production Packer can also be used effectively as a squeeze tool in the following wide variety of "Supplemental" applications that might be required in the completion or work-over phases of a well:

Testing—As many as ten Baker Packers have been used in a single well for an efficient, complete bottom-to-top testing program. Ability of the packer to withstand reverse in pressure differential from high-pressure acid squeeze to swabbing enhances its use as a successful testing tool.

Acid Squeeze, Formation Fracture, or Squeeze Cementing—Use of the Baker Packer as a squeeze tool in either the initial completion or during subsequent work-over is widespread, due to elimination of the unnecessary additional expense of running a separate squeeze or testing tool.

Water Flood or Gas Injection—The permanence of the Baker Retainer Production Packer, plus the advantage of a free tubing string, make it a superior packer for secondary recovery instal-

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

lations. The packer has also been used in dual-zone wells where one zone is produced, with simultaneous injection into the other.

Isolation of Annulus—The Baker Packer is corrosion resistant. This feature, plus the fact that the packer permits removal of the production string without disturbing the isolation of the zone below the packer (pressure differential must be from *below* the packer) make it an ideal packer for use in corrosive areas where protection of the casing above the producing zone is of great importance.

Bridge Plug, Temporary or Permanent—The Baker Packer acts as a one-way bridge plug whenever the tubing is removed from the well, provided the pressure differential is from below the packer. It can easily be converted to a temporary two-way casing bridge plug or a permanent bridge plug.

POPULAR APPLICATIONS OF: the Baker "Universal" Type Retainer Production Packer

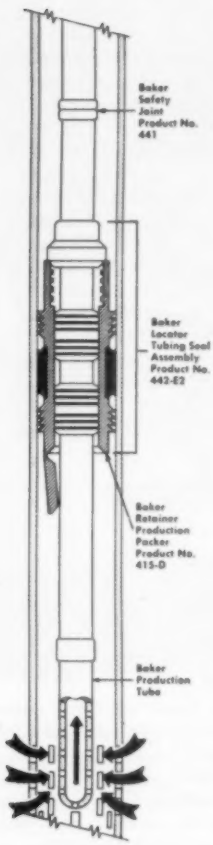
Baker Safety Joint Product No. 441
Baker Locator Tubing Seal Assembly Product No. 442-E2
Baker Retainer Production Packer Product No. 415-D
Baker Production Tube

Fig. 1

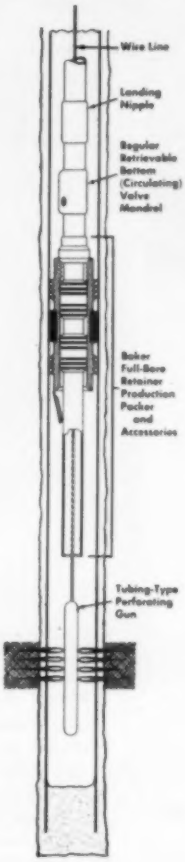
Wire Line
Landing Nipple
Regular Retrievable Bottom (Circulating) Valve Mandrel
Baker Full-Bore Retainer Production Packer and Accessories
Tubing-Type Perforating Gun

Fig. 2

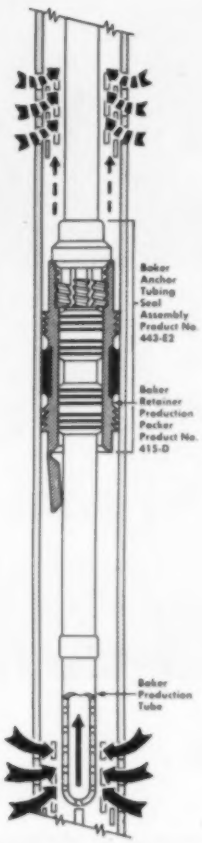
Baker Anchor Tubing Seal Assembly Product No. 443-E2
Baker Retainer Production Packer Product No. 415-D
Baker Production Tube

Fig. 3

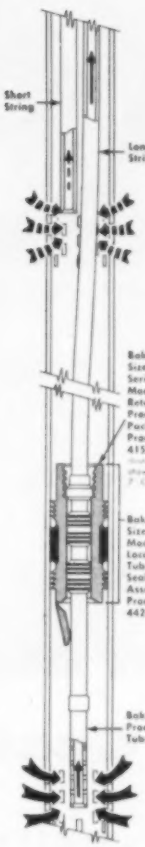
Short String
Long String
Baker Size 100 Series Model "D" Retainer Production Packer Product No. 415-D
Baker Size 100 Model "E" Locator Tubing Seal Assembly Product No. 442-E2
Baker Production Tube

Fig. 4

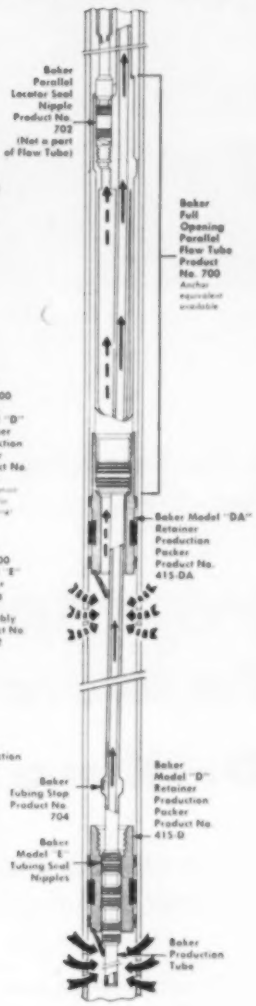
Baker Parallel Locator Seal Nipple Product No. 702 (Not a part of Flow Tube)
Baker Full Opening Parallel Flow Tube Product No. 700
Baker Model "DA" Retainer Production Packer Product No. 415-DA
Baker Tubing Stop Product No. 704
Baker Model "D" Retainer Production Packer Product No. 415-D
Baker Model "E" Tubing Seal Nipples
Baker Production Tube

Fig. 5

SINGLE-ZONE Fig. 1.—Illustrates Packer set in casing with Locator Tubing Seal Assembly and Production Tube installed for single-zone production.

PERMANENT-TYPE WELL COMPLETION Fig. 2—Illustrates typical Permanent-Type Well Completion Hook-Up showing perforating operation through and below the packer.

DUAL-ZONE, SINGLE PACKER Fig. 3—Illustrates Packer set in casing with anchored production string for dual-zone production. Tubing can be released from packer by rotating to right.

DUAL-ZONE, PARALLEL STRINGS, SINGLE PACKER Fig. 4—Illustrates the simplest form of parallel string installation. A variation permits anchoring short string to long string, if desired. Note full opening to lower zone for use of all permanent completion-type tools.

DUAL-ZONE, PARALLEL STRINGS, TWO PACKERS Fig. 5—Illustrates two-packer parallel string installation with each zone confined to its individual tubing string, with full opening to lower zone for use of all permanent completion-type tools.

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A new 72-page catalog supplement is now available on the Baker Retainer Production Packer and its many features and applications. Address any office, or ask your Baker representative for Baker Catalog Supplement No. 502.

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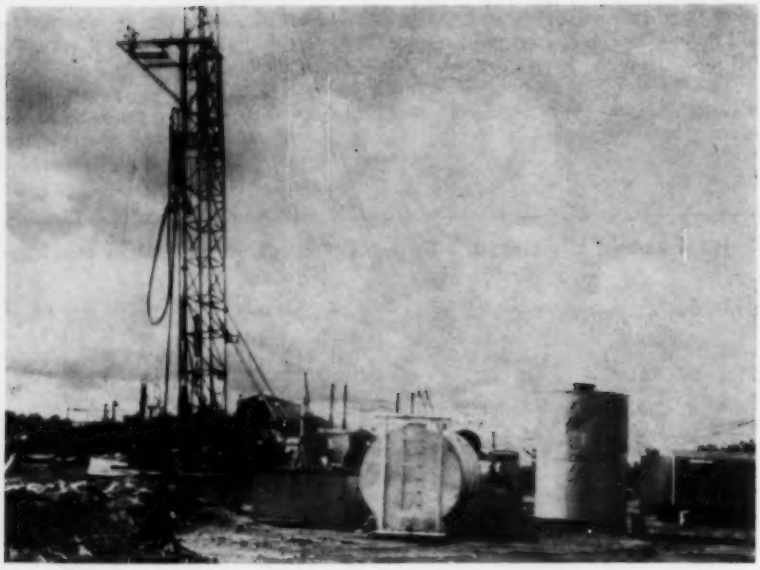

FIG. 1. **Inverted drilling mud system** included the storage tanks at right and the active steel mud tanks at left adjacent to rig.

What Is An Inverted Emulsion Mud?

Simplest answer would be that it is the reverse of an oil emulsion mud. In the conventional oil emulsion mud, minute oil droplets are dispersed in a continuous water phase. In such a mud, water is the "external phase" and the oil the "internal phase." This is an "oil-in-water" emulsion.

By "inverted" is meant that minute water droplets are dispersed in a continuous oil phase. Oil becomes the "external phase" and water the "internal phase." This is a "water-in-oil" emulsion. Control of such an emulsion is obtained by a chemical emulsifier. In the accompanying report, Magcobar's powdered emulsifier No-Blok was used. The inverted mud was made up in the rig mud tanks by adding water to oil while mixing in the emulsifier. Satisfactory systems can be made with 50 percent oil, 50 percent water and from 25 to 40 lb of emulsifier per bbl of fluid. Either fresh or salt water can be used as the internal phase.

In the Saskatoon area of Saskatchewan, Canada . . .

Inverted Emulsion Mud Cuts Drilling Costs

Protective casing string eliminated in drilling four 3500-ft wells to evaluate potash deposits

Reid M. Waltman
Southwest Potash Company, Denver, Colorado

and

Terry F. Cox
Magnet Cove Barium Corp., Ltd., Calgary, Alberta, Canada

THE USE of inverted emulsion drilling mud in four 3500-ft wells in the Saskatoon area of Saskatchewan, Canada, reduced drilling costs from $19,125 to $11,608 per well. Much of the savings resulted through the elimination of a protective string when drilling through the evaporites in this area. An inverted emulsion is one in which minute droplets are dispersed in a continuous phase of oil.

While the wells were part of an extensive exploratory operation to evaluate potash deposits, savings resulting from the use of this type mud have particular significance in reducing overall well costs. For these wells penetrated anhydrite, magnesium, potassium, and sodium salts; and whenever evaporites are encountered in development drilling, similar savings can be achieved. Actually, the savings resulting from drilling with an inverted emulsion in Canada proved to be a bonus cost reduction because the operators were primarily seeking a drilling mud which would improve previous drilling practices.

Potash Basin

Exploration. Exploration for potash deposits in South Central Saskatchewan during recent years has grown into sizable proportions. In 1957, 27 potash core tests with an average depth of 3400 ft were drilled in the potash basin of Saskatchewan and Manitoba. All major U. S. potash producers operating at Carlsbad, New Mexico, have been actively engaged in the Saskatchewan potash field at one time or another, either in the shaft sinking or drilling stages. In addition, French and German potash interests, local Canadian concerns and independent oil firms have conducted and, in many cases, are still conducting exploration activities throughout the basin.

Geology. Extensive potash deposits have been found in the Middle Devonian Prairie Evaporite formation throughout a large area in Central and Southern Saskatchewan and extending into Southeastern Manitoba. Although commercial grade potash zones have been encountered in oil well drilling below 7500 ft, the major economic deposits of potash extend in a 400 mile

This valve is the Mission 2-inch figure 400 valve. See Mission catalog for complete listing of sizes and pressure ratings

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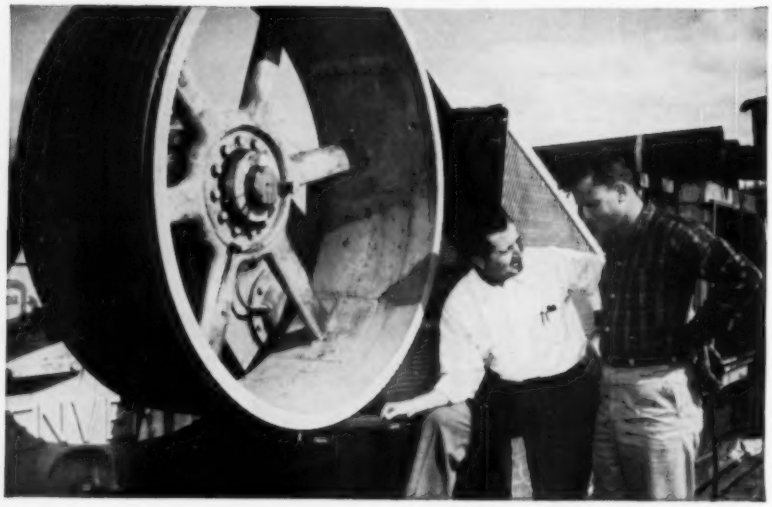
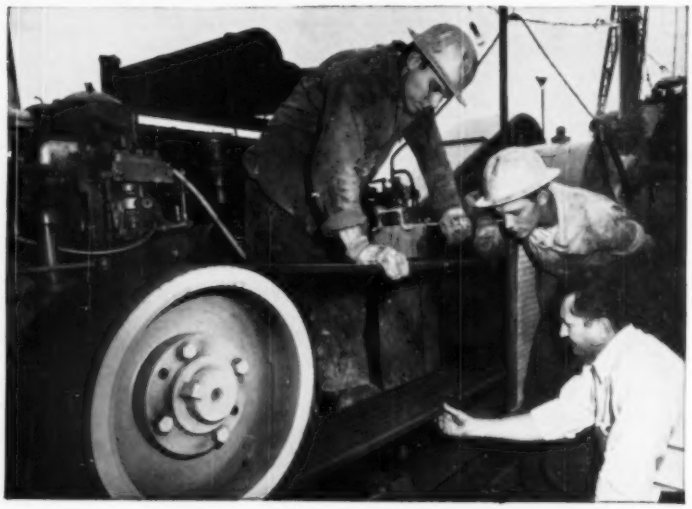


Jack Gresham, Toolpusher on Big Six Corporation's Rig # 2, says, "8 months ago, we switched to multi-matched Dayton Super-Thorobred V-Belts. Since then, Rig #2 has been on 12 jobs—sinking holes that averaged 9,000 feet in depth. In over 5000 hours of drilling, with the mud pump operating at 1800 psi, Dayton V-Belts have never caused one minute's downtime." Mr. Gresham is shown at the right, talking to Dayton Representative Werner Zapp.

"Because they're unaffected by oil, heat, moisture and static build-up, Dayton Super-Thorobreds resist every destructive condition we've found in our drilling operations. For instance, we were overtensioning our former V-Belts to compensate for slippage due to belt stretch. Using surer gripping Dayton Super-Thorobreds, with their extra strength cord section, we can slack off the tension while maintaining full power. That way, we let the belts soak up shock and vibration that was transmitted to the pump.

"Dayton believes in service, too. Our Dayton Distributor in Houston, is backed up with a large warehouse stock. Thus, we get the belts we need, have them multi-matched and at the rig in half an hour."



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A PLANNED MUD PROGRAM CUTS DRILLING COSTS ALL ALONG THE LINE

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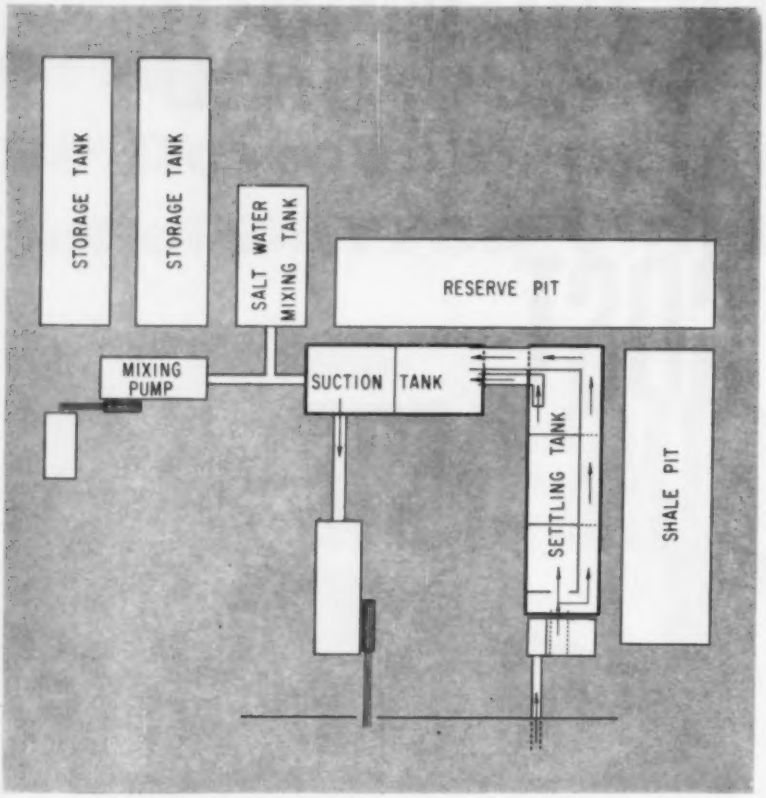

FIG. 2. **Surface drilling fluid circulating system** was designed especially to handle the inverted emulsion mud system.

northwest-southeast belt from Unity through Saskatoon to Yorkton and into Manitoba. While the economic depth to the potash may vary, most of the potash drilling in Canada has been confined to depths under 4000 ft along this belt.

A simplified geological column for South Central Saskatchewan is given in Table 1.

Drilling Fluid Search

Coring potash a problem. Potash core tests in the central portion of the Saskatchewan potash basin usually penetrated shales to 1600 ft; water-bearing sandstones to 2000 ft; limestones and varying amounts of evaporites (anhydrite and salt stringers) to 3200 ft, and deposits of potassium, magnesium and sodium salts to total depth. Because of the extreme solubility of these salt deposits in conventional water-base muds, the customary operations had not permitted the recovery of desired potash cores.

Prior to the use of inverted emulsion mud, it was customary to drill a 9-in. hole to the top of the salt section with a conventional water-base mud, cement 7-in. casing and then core the potash with diesel oil. An alternate method, used principally near potash producing mines, utilized a saturated potassium, magnesium and sodium chloride brine with or without casing to core the potash intervals. Because of the prohibitive cost of making such a brine and the close temperature control necessary to maintain this drilling fluid, most Canadian operators had favored the casing-diesel oil coring method. There were several disadvantages to this practice, however. Considerable time and costs were involved in running casing, waiting on cement, and salvaging the casing after coring. There were additional costs of the services necessary in cementing and pulling the casing, and the casing which could not be recovered. Casing loss ranged from 100 to 1600 ft per well.

Thus, operators needed a drilling fluid which would eliminate the protective casing problems but which would not dissolve or etch the potash cores. In addition, the drilling fluid had to be relatively inexpensive, easy for the drilling crews to handle, available in Canada and which could be used to drill from under surface casing to total depth.

Research on fluids. Southwest Potash Corporation, in their determination to find such a drilling fluid and cut their exploration costs, approached Magnet Cove Barium Corporation's research department with this problem. They set up an exhaustive test program to determine the best combination of oil, water, and emulsifiers to provide maximum protection for the potash cores.

The oil and water content was varied in order to ascertain the proper ratio that would provide a low viscosity fluid which would allow maximum settling of drilled solids. Since the viscosity of the inverted emulsion fluid would depend to a great extent on the viscosity of the oil phase itself, tests were conducted using different types of oils, such as diesel oil, fuel oil and light lubricating oil. These tests indicated the most satisfactory oil phase consisted of a blend of fuel oil (19 to 23 deg API) and diesel (35 deg API).

Water phase important. Possibly the most important factor was the water phase of the inverted emulsion and its chemical composition. Saturated salt water, salt water plus anhydrite and water saturated with all the soluble salts found in the potash deposits (NaCl, $MgCl_2$, KCl) were used in varying proportions. Tests conducted on both static and dynamic emulsions indicated that the water phase needed

TABLE 1. Simplified Stratigraphic Section, South Central Saskatchewan.

Age	*Formation*	*Type Sediment*
Quaternary	Pleistocene	Glacial drift
Cretaceous	Milk River	Shale
	Colorado	Shale
	Viking	Sand and sandy shale
Devonian	Blairmore	Sand and shale
	Three Forks	Limestone, shale
	Nisku	Limestone, shale
	Duperow	Limestone, shale
	Souris River	Limestone, anhydrite, salt
	First Red Beds	Shale
	Dawson Bay	Limestone, dolomite
	Second Red Beds	Shale
	Prairie Evaporite	Salt, potash
	Winnipegosis	Dolomite
	Ashern	Shale

Silurian, Ordovician and Cambrian not normally penetrated in potash wells.

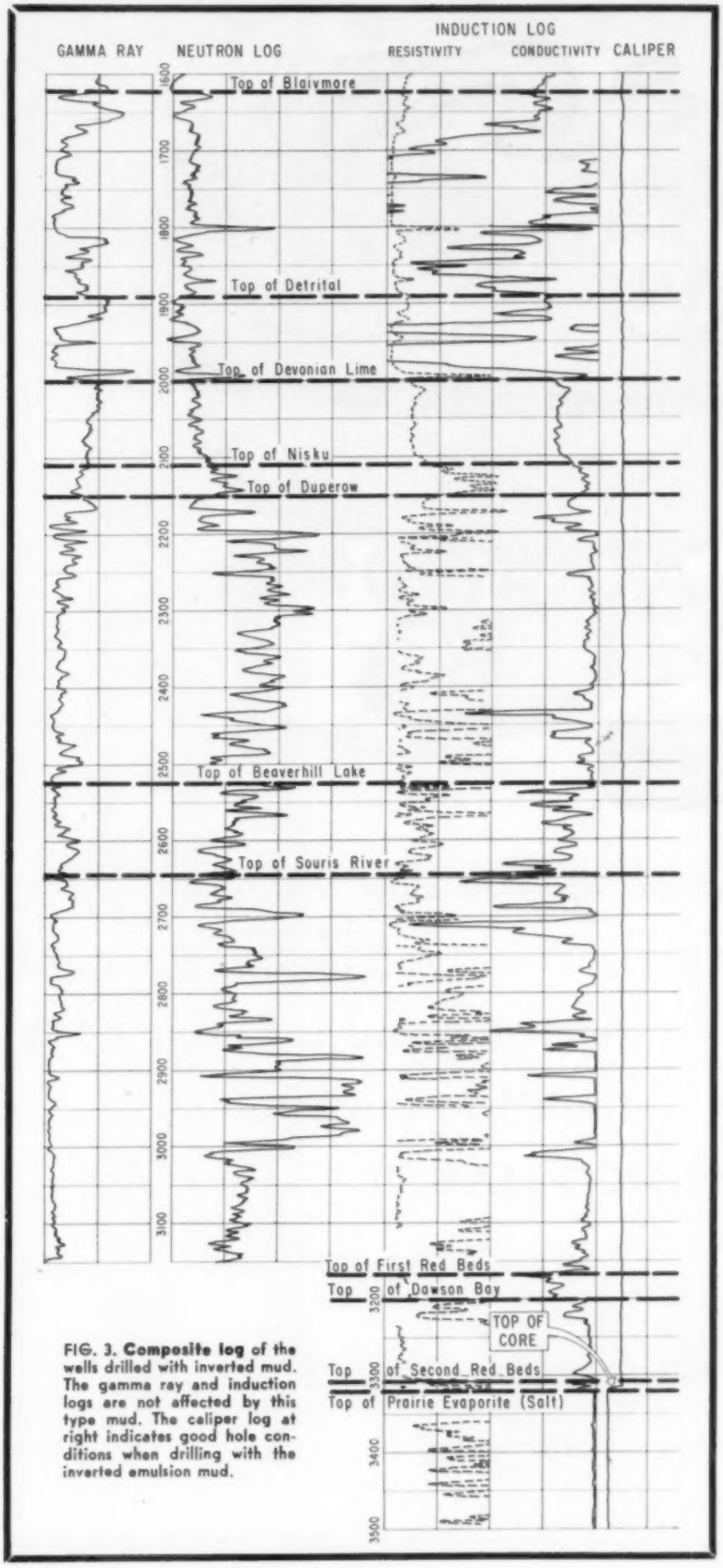

FIG. 3. Composite log of the wells drilled with inverted mud. The gamma ray and induction logs are not affected by this type mud. The caliper log at right indicates good hole conditions when drilling with the inverted emulsion mud.

only to be saturated with salt to insure minimum etching of the potash. Since magnesium chloride ($MgCl_2$) and potassium chloride (KCl) were not commercially available in the required quantities, the water phase of the initial well was saturated with salt (NaCl) only with excellent results.

Experimental Well. Following extensive laboratory testing an experimental well to use the inverted emulsion mud was arranged in July 1957. This was the first of the four-well program. Since the primary objective of these wells was obtaining 100 percent core recovery in the potash-salt section, the first experimental test was carefully supervised by both Southwest Potash and Magcobar personnel.

DRILLING PRACTICES

Mud system. The drilling rig selected by the operator had been specially equipped to handle the inverted emulsion mud. The surface mud system consisted of two steel tanks with by-pass ditch and fluid level control between the tanks. A 5- by 12-in. duplex mixing pump was used to mix saturated salt water from the salt water storage tank and keep the mud agitated in the suction tanks. Adjustable partitions were installed in the settling tank to promote maximum settling of drilled solids. The 6¾- by 14-in. circulating pump was normally operated at 50 to 60 strokes per minute at 500 to 600 psi. The contractor provided steel tanks (500 bbl) for storage of oil and inverted emulsified mud between wells. The mud mixing and storage system is shown in the photograph of Fig. 1 and the mud system layout diagram in Fig. 2.

After setting 360 ft of 10¾-in. surface casing, the surface system was thoroughly cleaned in preparation for the inverted emulsion mud.

The initial mud system was prepared with 25 percent saturated-salt water, 75 percent oil (a blend of 19 deg API and 35 deg API non-asphaltic fuel oils) and 100 lb of inverted emulsifier per bbl of watter. While waiting on cement, the system was constantly agitated in order to insure a tight, stable emulsion. Funnel viscosity at approximately 60 F was 60 to 65 sec per qt with a density of 8.1 lb per gal.

After waiting on cement for 24 hours, all water-base mud was displaced from the casing and the cement drilled with the new mud system.

Mud control. While drilling to about 3000 ft, the volume was maintained with the addition of oil only, the viscosity decreasing to 50 to 53 sec per qt and the weight to 7.8 to 7.9 lb per gal as the oil content increased to a

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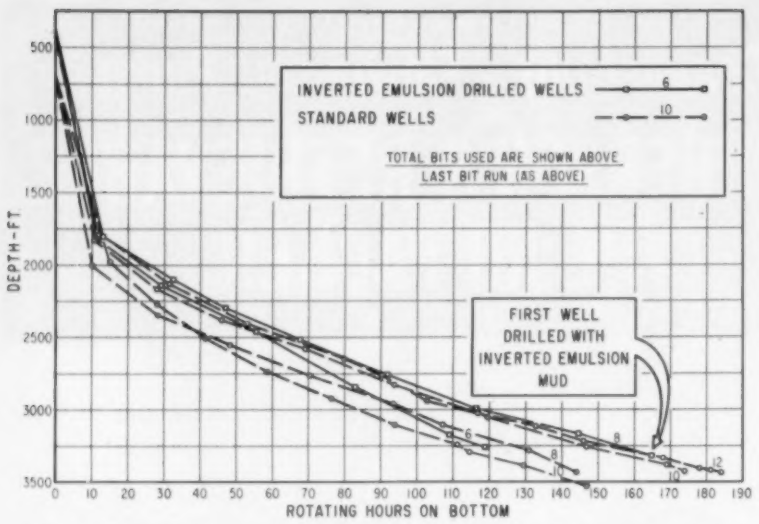
INVERTED EMULSION DRILLED WELLS
STANDARD WELLS
TOTAL BITS USED ARE SHOWN ABOVE
LAST BIT RUN (AS ABOVE)
FIRST WELL DRILLED WITH INVERTED EMULSION MUD
DEPTH-FT
ROTATING HOURS ON BOTTOM

FIG. 4. **Drilling rate comparisons in the Bradwell-Elstow area between wells drilled with the inverted emulsion mud and water-base muds.**

maximum of 88 percent. At this point, salt water and the inverted emulsifier were added to raise the viscosity in order to suspend the solids that had settled in the tanks.

A mud weight of 9.5 lb per gal was necessary to control an expected salt-water flow immediately above the potash deposit. Increasing the water content to 30 to 32 percent resulted in a viscosity of 95 to 100 sec per qt which was sufficient to suspend the solids necessary for the required weight. Maximum fluid loss was 1.8 cc oil while water content was only 10 to 12 percent. During the coring operation the fluid loss was always zero.

On the last three wells, 50 percent oil and 50 percent old inverted emulsion mud was mixed prior to drilling out from under the surface casing. The volume was maintained with oil and old mud while drilling to about 3000 ft where viscosity and weight were again raised with salt water, inverted emulsifier and drilled solids. Typical mud properties prior to coring were as follows:

Weight	9.4 - 9.6	lb/gal
Viscosity (API)	55 - 65	sec/qt
Fluid loss	0.0 - 0.2	cc (oil)
Oil content	67 - 69	% (by vol)
Water content	20 - 21	% (by vol)
Solids content	11 - 12	% (by vol)
Stability	160 - 180	volts

Hole conditions were excellent at all times during the drilling and coring operations. Caliper logs run on two of the four wells show perfect gage hole from surface casing to total depth through shale sections that normally slough extensively with waterbase muds (see Fig. 3, Composite Log).

Logging

Since oil, a perfect insulator, is the continuous phase in invert emulsion muds, conventional electric resistivity logs could not be run with the new mud. However, other logs, such as the induction, sonic, gamma ray and neutron logs, are not affected by invert emulsion muds and provide comparable information normally obtained from the electrical logs. The induction log is one of the few field logging devices which will provide values read directly from the log that approach the true formation resistivity factor. Thus, induction logs run in inverted oil emulsion muds can be a useful tool in the evaluation of possible oil producing formations.

Gamma ray-neutron and induction logs were run on all wells in addition to the caliper log on the first two.

Comparative Results

Results of this 4-well drilling project have been compared with several wells drilled in the immediate vicinity using the conventional casing-diesel method. These conventional wells were drilled in 1956 and 1957 by rigs familiar to the area and this method of postash drilling. Comparison of the two methods is shown in Tables 2, 3, and 4 and illustrated graphically in Fig. 4 and 5.

TABLE 2. Comparative Results Between Water Base and Inverted Emulsion Muds.

	Water base Mud	Inverted emulsion mud
Wells drilled	9	4
Total footage drilled	25,107 ft	11,726 ft
Total bits used	80	25
Rotating hours	1344½	542½
Feet per bit	314	469
Feet per hour	18.7	21.6
Bits per well	9	6
Average days per well	19.5	12.5

TABLE 3. Drilling Rate Comparisons in Various Intervals in The Bradwell-Elstow Area.

Type of mud used	Top and bottom of interval drilled-ft	Total footage	Number of bits used	Feet per hour	Rotating hours	Feet drilled per hour
*Inverted emulsion (first well)	365-3316	2951	8	370	165	17.8
Inverted emulsion (fourth well)	382-3245	2863	6	477	119½	24.0
Water base	418-3433	3015	12	251	184¼	16.3
Water base	690-3375	2685	9	298	141½	19.0
Water base	695-3440	2745	8	343	144¼	19.0
Water base	650-3530	2880	10	288	147¼	19.5
Water base	668-3420	2752	9	305	174	15.8
Water base	646-3200	2554	9	284	141	18.1

*Penetration and bit life lower on first emulsion well due to experimental nature of the test.

TABLE 4. Drilling Rate Comparison in Various Intervals in the Saskatoon-Sutherland Area.

Type of mud used	Top and bottom of interval drilled-ft	Total footage	Number of bits used	Feet per hour	Rotating hours	Feet drilled per hour
Inverted emulsion (second well)	370-3277	2907	5	581	112	25.9
Inverted emulsion (third well)	350-3355	3005	6	501	145	20.7
Water base	510-3385	2875	8	359	128½	22.2
Water base	494-3390	2896	7	413	130	22.2
Water base	468-3173	2705	8	338	153½	17.6

Coring Results

On all four wells in the 1957 drilling program, actual cutting of the cores with inverted emulsion mud presented no problems. Coring rates in the salt and potash sections were essentially the same as the casing-diesel oil coring method since the salt interval cores very rapidly. Some difficulty was experienced on the second and third wells in breaking off the core after each run. However, trial and error, experience and in one case a slightly built-up core catcher eliminated this difficulty.

A total of 11,726 ft of 9-in. hole was drilled and 825 ft of 6⅛ in. hole was diamond cored. The entire potash-salt interval selected in each well was cored in 24 to 28 hours with 100 percent recovery except for one mechanical failure. This failure was due to a damaged core catcher.

The salt cores exhibited a remarkable tendency to remain upright in one piece in the cored hole if not broken off at the base. The lost core interval probably could have been recovered but the operator elected not to utilize additional rig time as the interval lost was below the zone of interest.

Mud Storage

After logging and setting first abandonment plug through the salt section, the inverted emulsion mud was displaced with water-base mud from the reserve pit.

There was no evidence of deterioration of the emulsion during the storage of the mud for six to seven days between wells. The salvaged mud was added directly to the circulating system with no preliminary treatment or conditioning of any kind. After completion of the four-well program, 300 bbl of mud was stored for use in the future.

Cost Analysis

The following cost comparison of the two methods has been based on the same wells studied in the drilling rate comparison of Table 1. The cost per well for diesel oil in the conventional wells takes into account re-sale of the diesel oil remaining at the completion of the potash project.

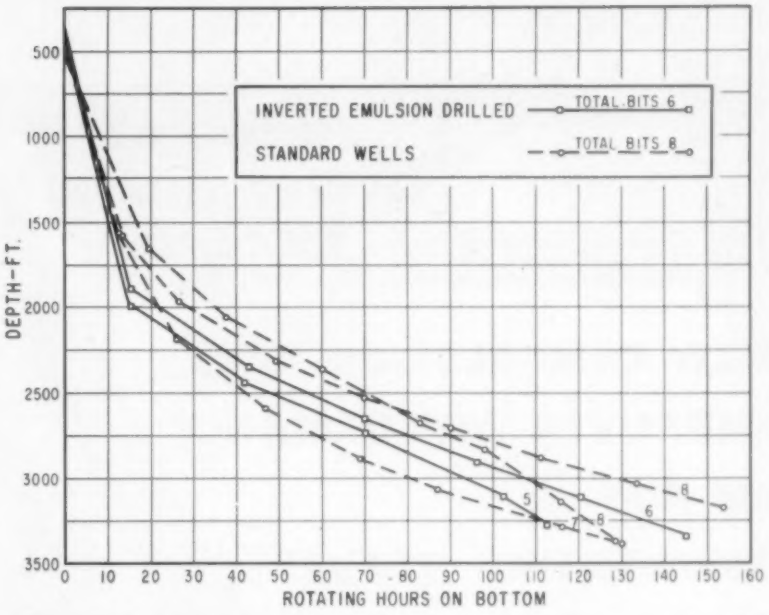

FIG. 5. Drilling rate comparisons in the Saskatoon-Sutherland area between wells drilled with the inverted emulsion mud a water-base mud.

$7519 Saved Per Well

The inverted emulsion mud system was used successfully for the complete drilling and coring operations on the four wells with the following results.

1. Overall savings compared with drilling the previous year (believed to be typical of the casing-diesel coring method) were $19,125 per well with $11,608 per well directly attributed to the emulsion mud application. The remaining savings of $7517 per well were made on more efficient coring, logging and analytical procedures.

Thus, the application of this inverted emulsion mud resulted in a 22 percent saving in costs per well and contributed 60 percent of the overall savings per well made in this four-well program over and above the cost of the mud itself.

2. The need for a protective casing string was eliminated with the resultant saving in lost casing, cementing, cutting, pulling casing and the rig time involved.

3. The highly soluble potash deposits were cored with very little evidence of solution or etching. Cores appeared to be scoured through mechanical action on a few cores.

4. Excellent formation cuttings were recovered and formation changes easily interpreted.

5. Caliper logs showed a perfectly gaged hole with no sloughing or wash outs in the shale sections and no solution of the salt or potash horizons.

6. Bit life and rate of penetration were increased.

TABLE 5. Cost Analysis of Inverted Emulsion Mud System.

Preparation and Maintenance (1st Well)	$ 5,756.45
Preparation and Maintenance (2nd Well)	3,536.31
Preparation and Maintenance (3rd Well)	2,270.42
Preparation and Maintenance (4th Well)	1,469.52
Total emulsion mud cost of 4 wells	$13,032.70
Cost per well (excluding salvage)	$ 3,258.17
Salvage (300 bbl @ $8/bbl)	2,400.00
Cost per well (including salvage)	2,658.17
*Cost per well (conventional method)	1,742.39
Net cost per well for emulsion mud	$ 915.78

*Includes water-base mud ($1344.89) and diesel oil ($397.50).

Acknowledgment

Much, if not all, of the credit for the success of these Canadian operations should be given to the contractor and his crews, the personnel of the Southwest Potash Corporation, and the service engineers of Magnet Cove Barium Corporation. Without the excellent cooperation and perseverance of all these people, the job could not have been accomplished.

The authors wish to express their appreciation to the management of the Southwest Potash Corporation and Magnet Cove Barium Corporation for permission to publish this article. ★ ★

NEW COMPRESSION RING IMPROVES PERFORMANCE OF GOT CIRCULATING VALVES . . . PROVIDES POSITIVE FUNCTION AT ALL DEPTHS

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The result is the new compression ring illustrated in cross-section at the top of this page. Exhaustive tests revealed that this ring allowed the sleeves in GOT Circulating Valves to be shifted in either direction with a practically uniform force, regardless of valve size, well depth, mud weight or bottom hole pressure. While the original snap ring seemed good enough, this new compression ring is so much better that henceforth all GOT Circulating Valves and other sliding sleeve valve equipment will be fitted with it. The improved design also prevents foreign matter from collecting above the ring.

For detailed information on this and other GOT products, see your GOT representative or write for the GOT General Catalog.

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Before delivery to the oil fields every piece of Spang high strength casing and tubing from National Supply must pass this rigid Magnaglo Inspection.

Spang high strength casing and tubing get full-length Magnaglo Inspection!

THE NATIONAL NSCO SUPPLY COMPANY

You can't compromise on quality—especially if the product is an investment like casing and tubing for a deep well. So ordinary visual inspection isn't good enough for these Spang tubular products. We look *full-length* for surface defects on one of the largest and most efficient "black light" inspection units ever installed in any pipe mill.

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The full-length Magnaglo Inspection of Spang high strength tubular goods is further proof that you get the best—in design, manufacturing care and performance—when you buy from National Supply.

The streamlined interior and exterior contours of Spang Extreme Line Casing insure maximum round-the-clock running efficiency. The rugged integral joint is 100% leak-resistant.

Spang Extreme Line Casing runs in faster, has 100% leakage resistance!

Drilling crews like to work with SPANG Extreme Line Casing because it's easy to handle. When they're running-in, only 5 to 7 turns with the spinning line and less than one turn with the tongs are necessary. It's very easy to stab, *cannot* be cross-threaded, and its positive shoulder contact engagement prevents overtonging. But there are more good reasons.

The streamlined interior and exterior contours of this high quality casing provide for maximum running efficiency—no shoulders to hang-up on hole projections, or to scrape mud seal from the walls of the hole. SPANG'S high strength integral joint provides a minimum of threaded connections—and this means less possibility of joint trouble.

Precision-manufactured SPANG Extreme Line Casing pays off *in* the well, too. It has the mechanical and metallurgical properties to withstand high tensile loading, and to resist the severe pressures found in present-day deep drilling. Its rugged integral joint is 100% leak-resistant—a highly important factor in deep, high-pressure wells. Another outstanding fact is that SPANG Extreme Line Casing can be salvaged and re-run repeatedly.

You can easily get more information about this quality casing *in terms of your specific needs* by calling the National Supply representative in your area. Find out soon how SPANG Extreme Line Casing can save you money in the long run.

Spang Casing ready for action on a well in Texas. You can get Spang Extreme Line Casing in three grades for every well condition–J-55, N-80 and P-110. The O.D. size range is 5" to 9⅝".

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Spang CW is quality-controlled from skelp to finished product, and this control pays dividends on a wide variety of piping installations.

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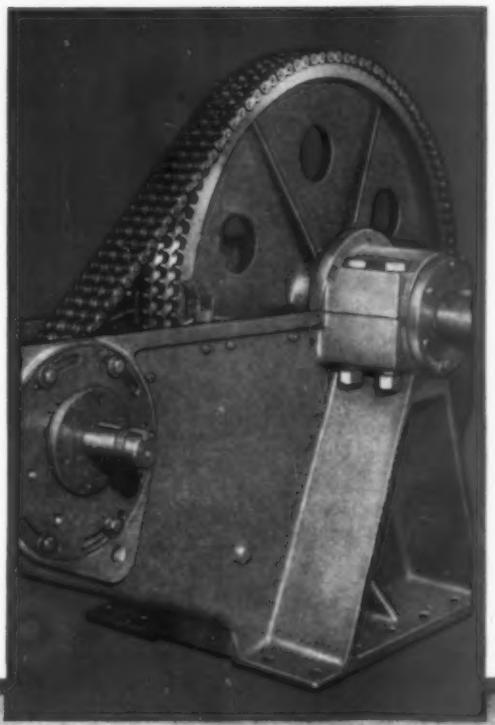
On original equipment or for replacements, buy Diamond Roller Chains. Their extra stamina means lower pumping and drilling costs.



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The Plunger Lift Method of Oil Production

Free piston performance may be predicted where depth, static bottom-hole pressure, productivity index and anticipated minimum tubing pressure are known

Carrol M. Beeson,
Petroleum Engineering Department, The University of Southern California, Los Angeles, California

Donald G. Knox and John H. Stoddard,
The National Supply Company, Los Angeles, California

PART 3 HOW TO USE NOMOGRAPHS TO ESTIMATE PERFORMANCE

Purpose of Nomographs

PURPOSE OF THE NOMOGRAPHS is to permit graphical solution of the problem of estimating free piston performance for a given well. Construction of the nomographs was based on formulas derived by the method of least squares from actual field data. Supplementary figures in this series provide a means for determining the probable requirements of gas volume and casing pressure, when size load and production rate are read from a nomograph.

Solution of the problem is obtained by plotting the operating line for a well. This line relates size load to gross production rate, and therefore represents a well's ability to produce by the free piston method.

For a given depth, there is an upper limit to the production rate, the limit being fixed by the time required for the plunger to complete a cycle. Accordingly, the nomographs include curves for various depths which represent the maximum production rates attainable by the free piston method for various size loads. The intersection of a well's operating line and the appropriate limiting depth curve, therefore, will indicate the highest rate of production expected for the well plotted.

By accepting lower production rates, the plunger may be operated with larger size loads and at higher net operating pressures to obtain lower gas-liquid ratios. Daily volumes of gas and the corresponding cost may readily be compared with rates of production to determine the most economical operation for the well being studied. The effect of a well's formation gas-liquid ratio upon the production rate may be predicted by plotting a supplementary operating line.

NOMOGRAPH INSTRUCTIONS

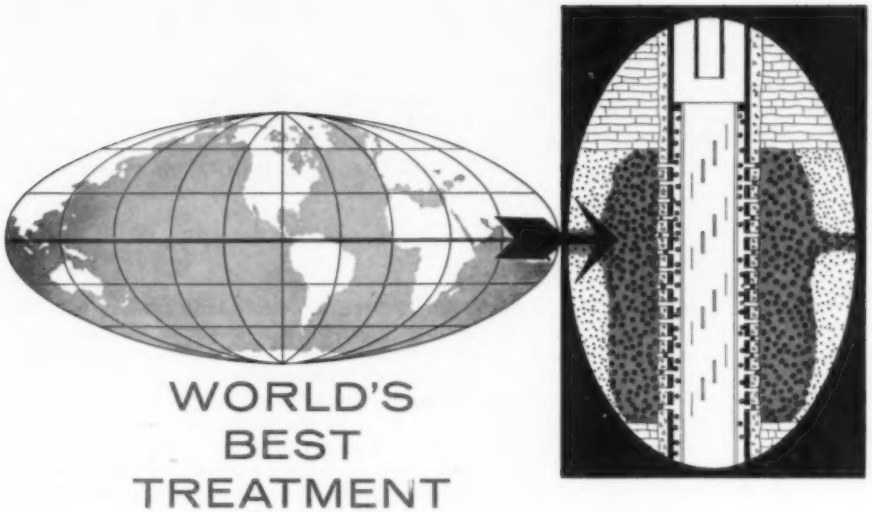
In using the nomographs to estimate free piston performance in a given well, aside from tubing and casing sizes, the following information is needed: (1) Depth, (2) static bottom-hole pressure, (3) productivity index, and (4) anticipated minimum tubing pressure. The depth is taken as the distance from the surface to the bottom of the tubing (or to the point at which gas enters the tubing from the casing). The static bottom-hole pressure should be referred to this depth. The productivity index is considered to be a constant in the nomographs, and so should be an average value, if known to vary with the production rate. The values used for static bottom-hole pressure and productivity index should be as recent as possible and consistent with the known production rate and computed or measured flowing bottom-hole pressure. The minimum tubing pressure should be estimated from the trap or separator pressure, and expected pressure losses in the flow line, if not known from field observation. Whenever static pressure and productivity index are unknown, it may be possible to estimate their limits and to plot a pair of operating lines to obtain the probable range of free-piston performance. Throughout the nomographs and figures, interpolation is permitted between lines representing depth, pressure, productivity index and size load.

Step 1:

Multiply the anticipated minimum tubing pressure by $0.990\ (1 + 0.027\ \frac{D}{1000})$ for the 2-in. plunger or by $0.974\ (1 + 0.027\ \frac{D}{1000})$ for the 2½-in. plunger. Subtract this amount from the static bottom-hole pressure to obtain the value for use in Steps 2 and 3.

Step 2:

Enter the left-hand chart of the nomograph and proceed up the appropriate depth line to the curve representing the value obtained in Step 1. At this point, turn right and move horizontally to the barrels-per-cycle axis. This point is designated intercept 1.



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In another case, 17 wells in another producing area were treated by Halliburton's FRACPAC. Sand control was effective, and the gain in total production attributable to this technique was estimated at more than 70,000 barrels!

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ANOTHER IMPORTANT CONTRIBUTION FROM HALLIBURTON RESEARCH

Plunger Lift Method

Step 3:

On the upper right-hand chart, proceed down the proper depth line to the value determined in Step 1. Now turn left and move horizontally to the line representing the productivity index of the well. Then turn and go vertically down to the barrels-per-day axis. This point is designated intercept 2.

Step 4:

Connect intercept 1 and intercept 2 with a straight line which is solid from intercept 1 to the appropriate depth curve and is dotted from that point to intercept 2. The solid portion of this line is the operating line. Directly below the intersection of the operating line and the depth curve may be read the maximum production rate expected for the well. The value on the barrels-per-day axis opposite this intersection is the size load which will be lifted at the maximum production rate.

The number of cycles per day is computed by dividing barrels per day by barrels per cycle, and the number of minutes per cycle is equal to 1440 divided by the number of cycles per day. Use Fig. 1 (for 2-in.) or Fig. 3 (for 2½-in.) to find the required gas-liquid ratio gradient (gas-liquid ratio divided by depth in thousands of feet) from the predicted size load, depth, and the expected minimum tubing pressure. Multiply this value (for gas-liquid ratio gradient) by the depth in thousands of feet (D/1000) to determine the required gas-liquid ratio. Multiply the latter figure by the predicted production rate to obtain the gas volume. Use Fig. 2 or Fig. 4 to find the net operating pressure from the predicted size load and known depth. Add this value to the minimum tubing pressure to obtain the probable maximum casing pressure.

Step 5-A:

Compare the required gas-liquid ratio gradient with the expected formation gas-liquid ratio gradient. If the probable gas requirement is greater than the well is expected to make, there are two possible situations. If outside gas is available, it may be circulated at a constant rate down the casing of the well in an amount necessary to increase the gas-liquid ratio gradient to the required value. In the second situation where no outside gas is available, use Equation 3 or Equation 4 to compute the size load which can be lifted with the expected formation gas-liquid ratio gradient, at the known depth and anticipated minimum tubing pressure. Mark a point on the operating line opposite this value of barrels per cycle, and read the predicted gross production

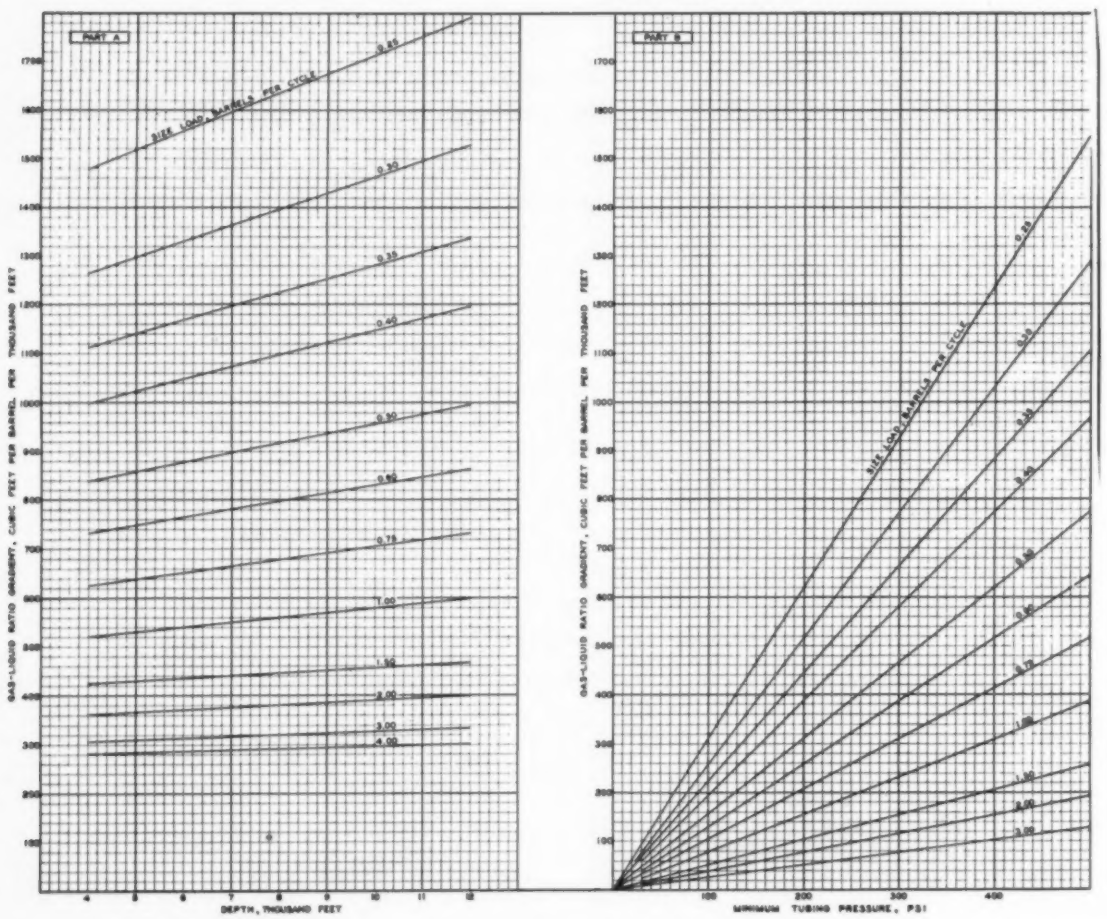
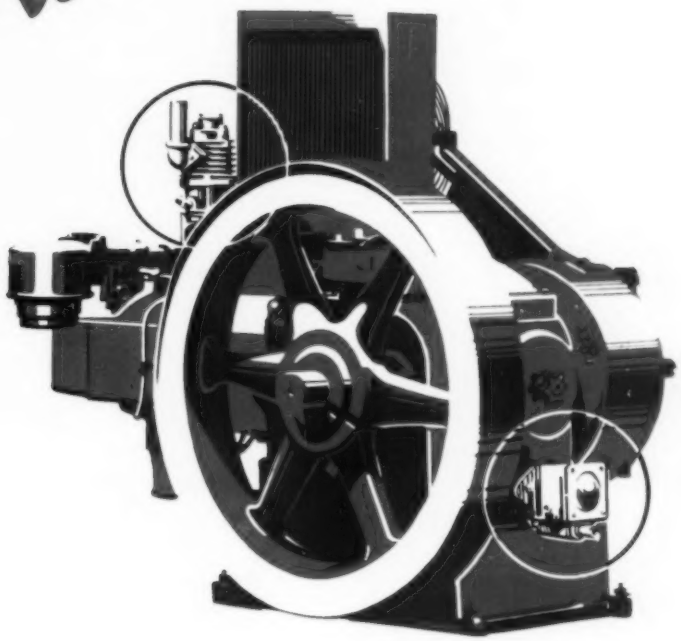


FIG. 1. Gas-liquid ratio gradient (gas-liquid ratio divided by depth in thousands of feet) is determined from the predicted size load, depth, and expected minimum tubing pressure. Add Part A to Part B. (2-in. plunger.)

LOWER LIFTING COSTS WITH C-E ENGINES

Ren-automated



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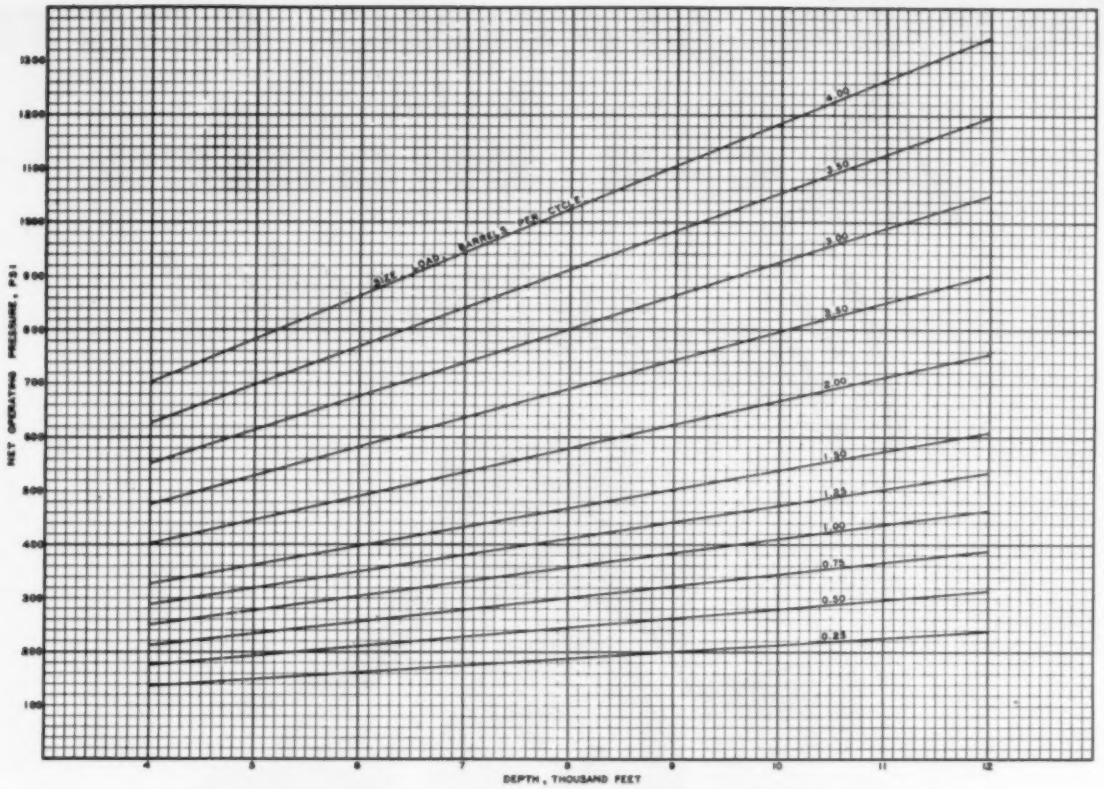

FIG. 2. Net operating pressure is found from the predicted size load and known depth. Add this value to minimum tubing pressure to obtain maximum casing pressure. (2-in. plunger.)

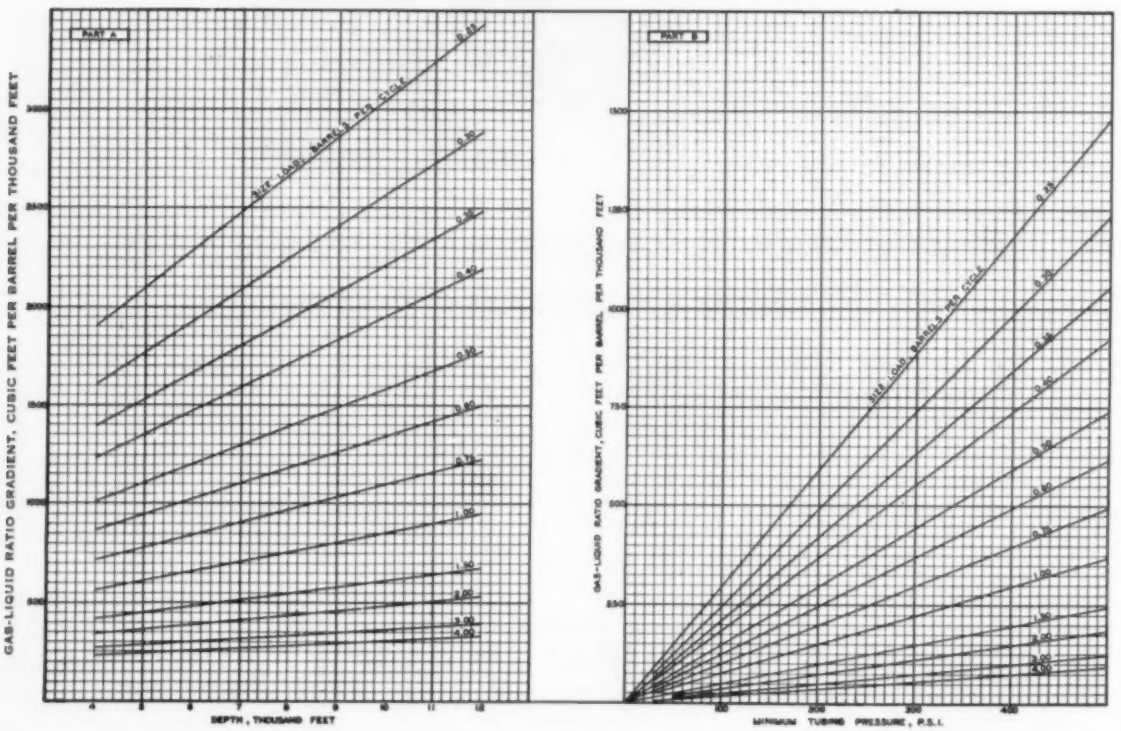
PART A
PART B
GAS-LIQUID RATIO GRADIENT, CUBIC FEET PER BARREL PER THOUSAND FEET
SIZE LOAD, BARRELS PER CYCLE
DEPTH, THOUSAND FEET
MINIMUM TUBING PRESSURE, P.S.I.

FIG. 3. Gas-liquid ratio gradient (gas-liquid ratio divided by depth in thousands of feet) is determined from the predicted size load, depth, and expected minimum tubing pressure. Add Part A to Part B. (2½-in. plunger.)

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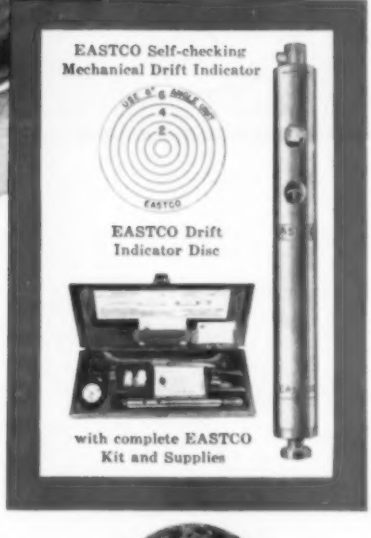

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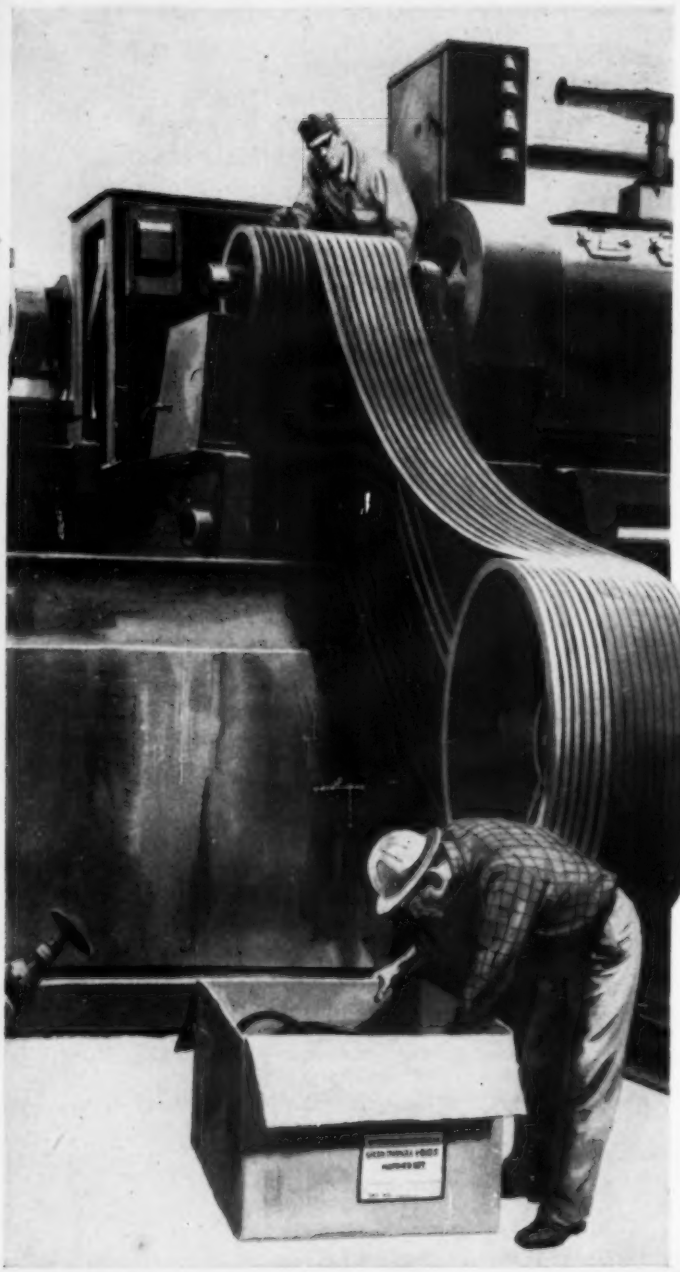

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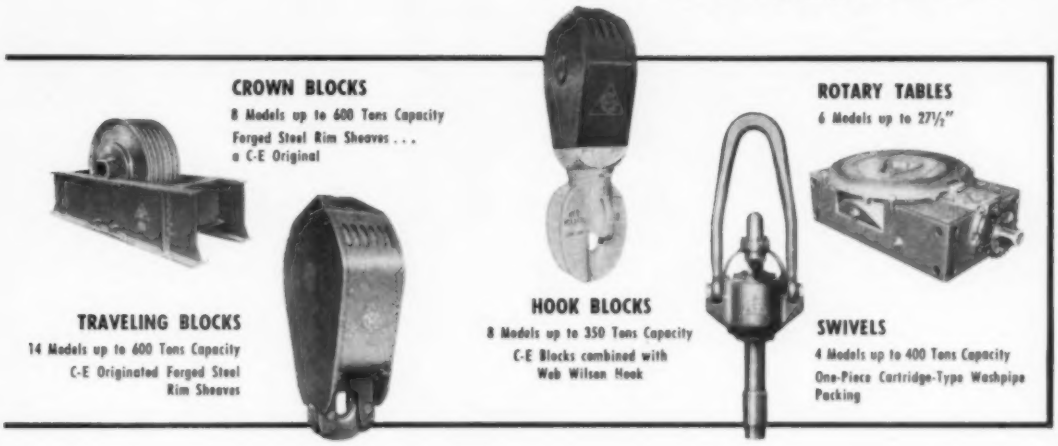

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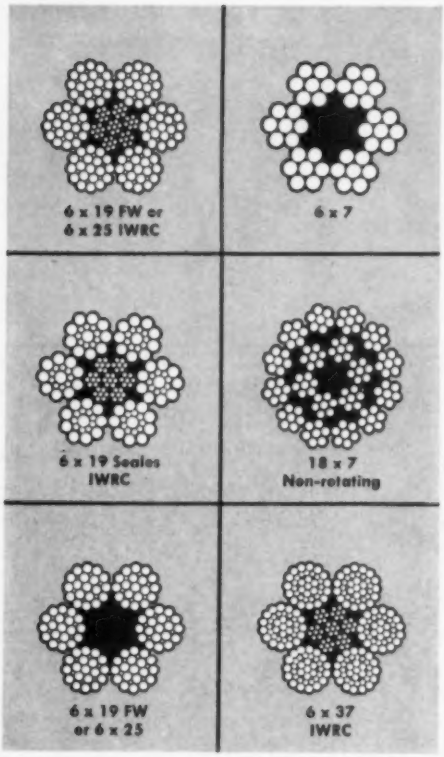

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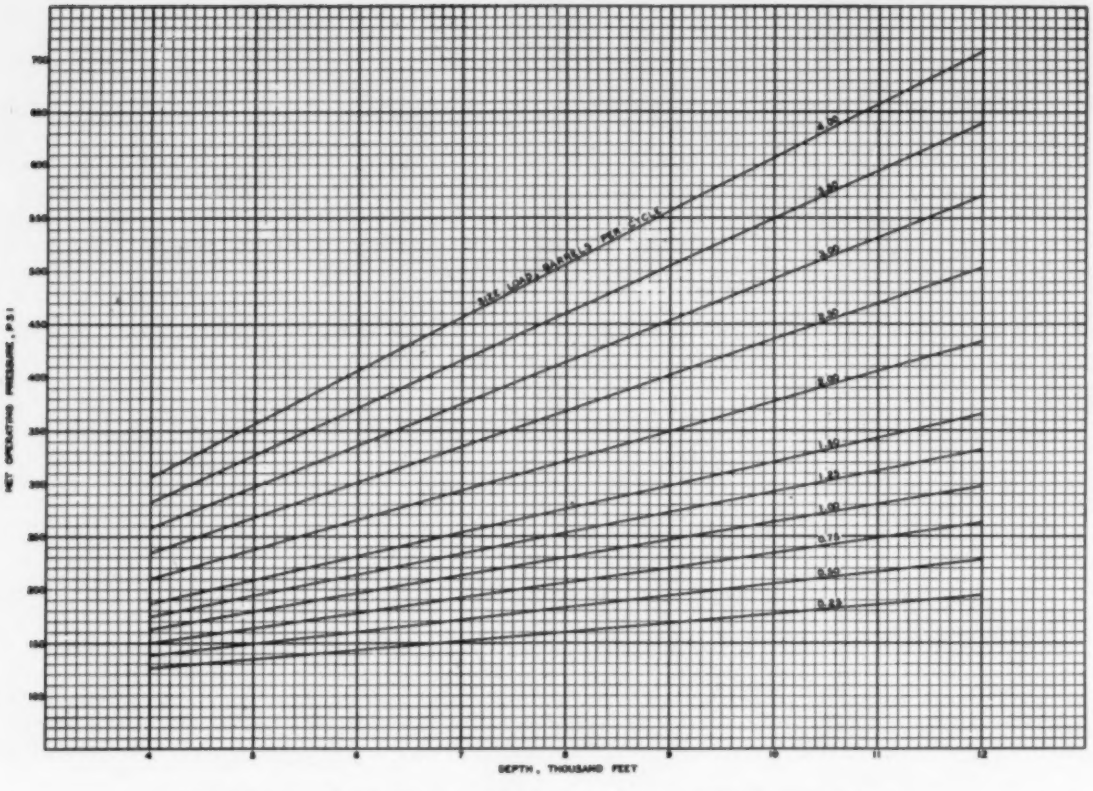


FIG. 4. Net operating pressure is found from the predicted size load and known depth. Add this value to minimum tubing pressure to obtain maximum casing pressure. (2½-in. plunger.)

rate on the barrels-per-day axis directly below this point. The values of cycles per day, minutes per cycle, and maximum casing pressure may be computed as in Step 4.

Step 5-B:

If the required gas-liquid ratio gradient is less than that expected from the well, there are two alternative courses. In the first of these, the excess gas is allowed to flow out of the tubing or the casing, either intermittently or at a constant rate, to obtain the maximum production rate predicted in Step 4. The second alternative involves operation of the plunger in the standard manner while accepting the production rate obtainable under these conditions.

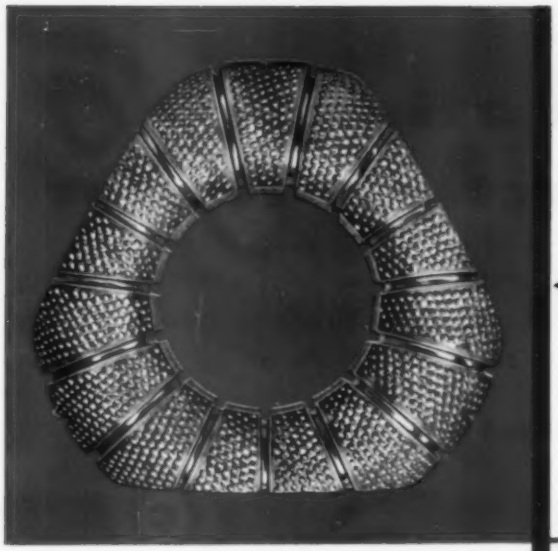
In this second alternative, where no provision is made to remove the excess gas, the effect of the excess gas on the production rate may be determined by plotting a supplementary operating line:

1. Refer to Equation 3 (for 2-in.) or Equation 4 (for 2½-in.) and compute the size load which corresponds to the expected minimum tubing pressure, depth, and formation gas-liquid ratio gradient. Make a mark at this size load upon the dotted extension of the operating line on the nomograph. Let this point be designated intersection of operating lines.
2. This differs from Step 3 in that the minimum tubing pressure is not considered. Furthermore, a value is computed which is to be added to the static bottom-hole pressure. For the 2-in. plunger, the added value is $(1 + 0.027 \frac{D}{1000})$ $(12.67 \frac{D}{1000} + 356)$. In the case of the 2½-in. plunger, the value is $(1 + 0.027 \frac{D}{1000})$ $(63.1 \frac{D}{1000} + 335)$. Re-enter the upper righthand chart and proceed down the proper depth line to the appropriate value of static bottom-hole pressure plus the value computed above. Now turn left and move horizontally to the proper productivity index line. Then turn and go vertically down to the barrels-per-day axis. This point is designated intercept 2A.
3. Draw a straight line from intercept 2A through the intersection of operating lines, which is solid above and dotted below the point at which the line intersects the appropriate depth curve. Directly below the intersection of the supplementary operating line and the depth curve may be read the production rate predicted for the given conditions. The value on the barrels-per-cycle axis opposite this intersection is the size load which will be lifted at this production rate.

The values for cycles per day and minutes per cycle may again be computed as in Step 4. The minimum tubing pressure is computed from Equation 3 or Equation 4, using the size load just determined and the given gas-liquid ratio gradient and depth. Use Fig. 2 or Fig. 4 to find the net operating pressure from the size load just determined and the known depth. Add this value to the minimum tubing pressure, to obtain the required maximum casing pressure.

TO BE CONTINUED

Part 4 "Examples Demonstrate Use of Nomographs" of this 5-part series will appear next month.



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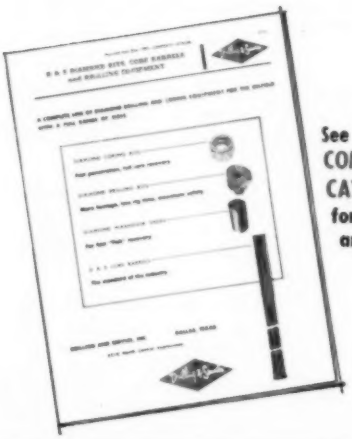

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Part 1 of 2 Parts

P 538.22

ABC's of Treating and Handling Injection Water

Basic concepts for surface systems, including methods, filter specifications, rates, turbidity factors and an analysis of oil field brines

Part 1. Water Treating Theory and Filtration Equipment

Lawton L. Laurence and Wayne E. Leuszler
Black, Sivalls & Bryson, Incorporated
Oklahoma City, Oklahoma

There are numerous problems encountered in handling and disposing of salt water produced with oil. In the water drive production of oil, the ratio of water to oil increases as the field nears depletion. It is not uncommon to produce wells that yield 98 percent water and 2 percent oil. In some cases, the disposal of produced water is an acute problem. Water produced with oil contains varying proportions of minerals. In some cases, water produced is a heavy brine.

The degree of water treatment required will depend upon the conditions of the water and characteristics of the formation into which the water is injected. Conditions under which water disposal systems operate vary widely from one location to the next.

PURPOSE OF SALT WATER DISPOSAL SYSTEMS

Rigid state restrictions prohibit dumping salt water into fresh water streams and also regulate dumping waste water into the Gulf or ocean. The most practical method of salt water disposal is to return the produced water to the producing formation at a point below the oil-water interface. This method has a three-fold purpose: (1.) It disposes of the salt water; (2.) It helps to maintain the reservoir pressure, and (3.) It increases the ultimate recovery of oil from the formation.

In locations near the Gulf or ocean and particularly on offshore installations where the water is not reinjected, it is necessary to remove the final traces of oil from the disposal water before releasing water into the Gulf or ocean to protect marine life.

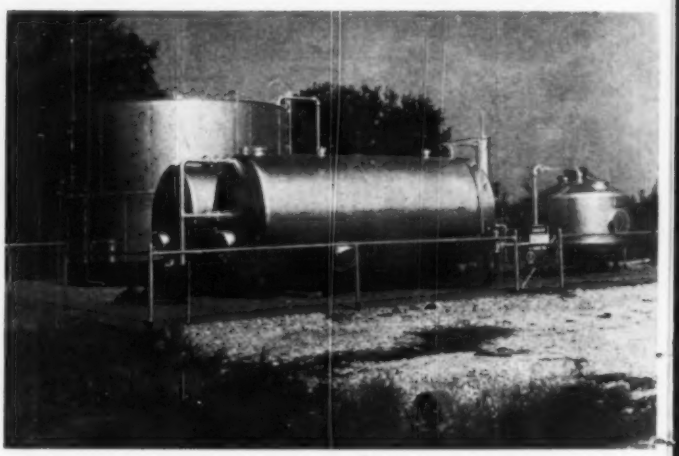
In other locations, it is also necessary to remove any solids that may be present in the disposal water. Solids tend to plug the formation into which they are injected, increasing the injection pressure in time, and making the injection well inoperable.

Methods of Handling Injection Water

There are two types of systems used to handle water for injection or secondary recovery, namely, the closed system and the open system.

Closed system. In the closed system the water is prevented from coming in contact with air. Advantages of a closed system over an open system are:

1. Exclusion of oxygen prevents oxidation of iron that may be present in solution. Oxidation of iron in solution causes a precipitate to form.
2. Exclusion of oxygen holds corrosion to a low rate.



Elements of water treating system include a filter (far right) oil skimmer tank and backwash tank.

3. Maintenance of pressure on the water holds the carbon dioxide in solution. Release of carbon dioxide from solution causes precipitation of calcium and magnesium.
4. Exclusion of oxygen prevents the growth of aerobic bacteria.
5. The use of a closed system eliminates the need for chemical treatment of water in most cases.
6. Stability of the water is maintained and it can be reinjected in essentially the same condition that exists in the producing formation.

The closed system usually consists of two basic steps, namely oil skimming and filtration. Sometimes it is necessary to add chemicals or bactericides to control the growth of bacteria.

Open systems. In the open system, no effort is made to exclude air from contact with water or to keep gases in solution by maintaining pressure on the water.

The open system consists of five basic steps, namely, oil skimming, aeration, chemical treatment, sedimentation and filtration.

In most cases, water is aerated in spray ponds, tray or forced draft type aerators to remove hydrogen sulfide and carbon dioxide gases, and oxidize the dissolved iron so insoluble iron components will precipitate.

Chemicals are added to flocculate and hasten the settling

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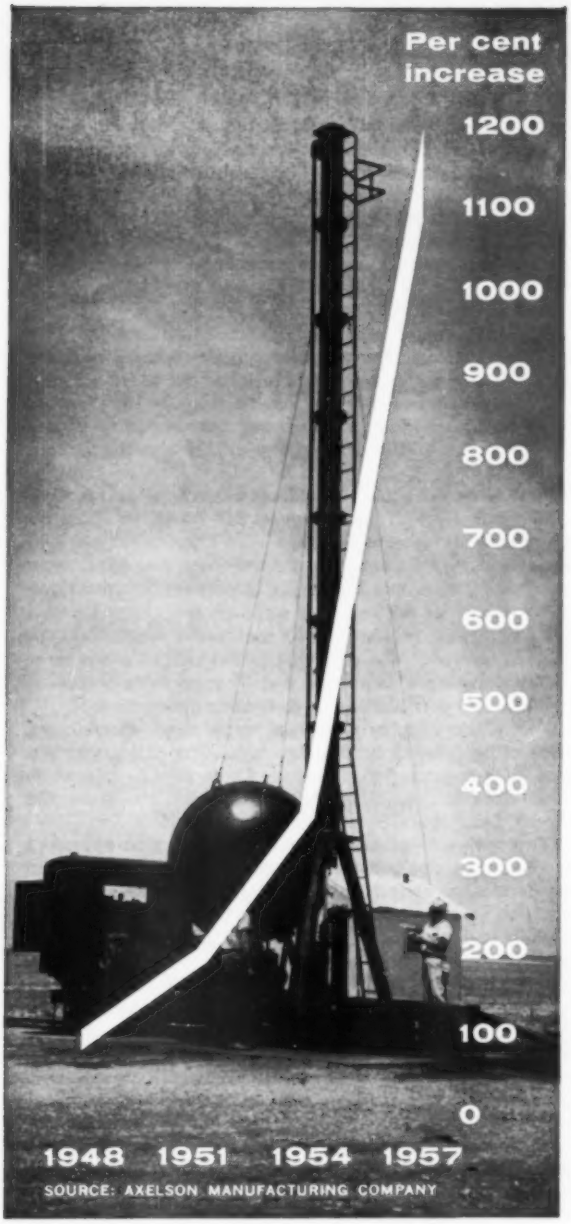

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and removal of suspended matter. A settling period is required to permit suspended and coagulated matter in the water to settle before filtration.

Each system is adequate if properly applied. Unfortunately, either system may be so incomplete that the treated effluent water is more harmful to the injection system than the influent water. The closed system may be used where it has no chance to work, or is not actually operated as an air-free closed system. Insufficient chemical treatment, aeration or settling may cause an open system to be inoperative.

Chemical Analysis

Frequently return or produced water is mixed with water from a supply well. If the mixed waters are corrosive or contain harmful bacteria, corrosion inhibitors or bactericides or both may be added to the water.

However, the supply and produced water both should be analyzed in order to determine whether or not any precipitation of dissolved solids will occur by mixing the two waters.

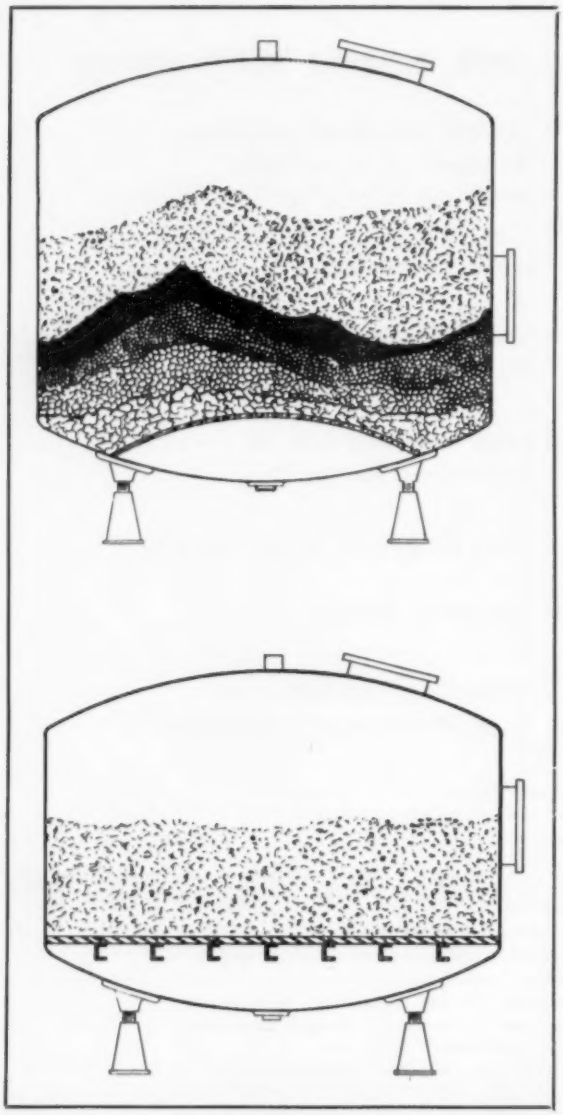

FIG. 1. Two types of filters used for treating water are the graded bed type (top) and the permeable plate type (bottom). After backwashing, graded bed may be partially disrupted.

Since the chemical composition and characteristics of the water are deciding factors in determining the proper treating equipment, competent chemists or laboratories should be consulted for water analysis.

FILTRATION OF INJECTION WATER

Filtration may be defined as the act of passing any liquid containing suspended matter through a suitable porous material and effectively removing suspended matter. Filtration will not remove any significant quantity of solids such as organic material in solution, dispersed oil, or dissolved salts. But, filtration will remove turbid matter, suspended undissolved solids and certain forms of bacteria.

Types of Filters

One of the most important operations in water treating is proper filtration. Large settling ponds or tanks could be used to allow suspended solids to settle out of the influent water by gravitational difference. The time required would make this method impractical and uneconomical. Filters are used to hasten the removal of particles from the influent water.

Slow filters. The first sand filters were developed in England about 1829. These "slow sand" filters, or "English filter," now obsolete, were designed on filtering rates of 0.03 to 0.06 gal per min per sq ft. Backwashing was impractical therefore, the accumulated layer of suspended matter and about an inch of the sand was scraped off.

Rapid filters. In about 1880 the "rapid sand" filter, or "American filter," was developed. Methods of cleaning or backwashing were improved and filtering rates increased to 2 or 3 gal per min per sq ft of filter area.

Today, there are two types of "rapid sand" filters being used; either gravity or pressure type. The primary difference is in construction. Pressure filters may be placed in water lines to operate under a desired pressure while the gravity filter operates under a gravity head.

Two types of pressure filters being used in industrial and water treating installations are the graded bed type and the permeable plate type. A typical cross-sectional view in Fig. 1 shows dispersed beds after the filters have been backwashed and put into operation. The graded bed may be partially disrupted as indicated.

Graded bed filter. The graded bed type pressure filter has four 6-in. thick graded layers of coarse material diminishing to a 24-in. layer of fine filter media at the top. The coarse bottom layer of the graded bed is supported by a perforated plate which distributes the water during backwash. The coarse material does not remove any solids from the water during the filter cycle. It supports the layer of fine filter media. Several types of pipe spreaders with holes, strainer nozzles or special caps are available to distribute the water in place of the perforated plate. The inlet distributor which is removable may be a flat plate type or a pan type with removable arms.

Permeable plate filter. The permeable plate type pressure filter uses a single grade of fine filter media supported on a layer of porous underdrain plates constructed of aluminum oxide. These plates are permeable to allow water to flow with a minimum pressure drop while retaining the fine filter media. The inlet distributor which is removable may be a flat plate type or a pan type with removable arms. No special spreaders or nozzles are required as the permeable plates distribute the flow evenly. A small deflector plate protects the plates from initial pressure surges.

Permeable plate type pressure filters have several distinct advantage over graded bed type filters:

1. The permeable plates (1¼-in. thick) replace the 24 in. of graded support bed required in other types of filters.

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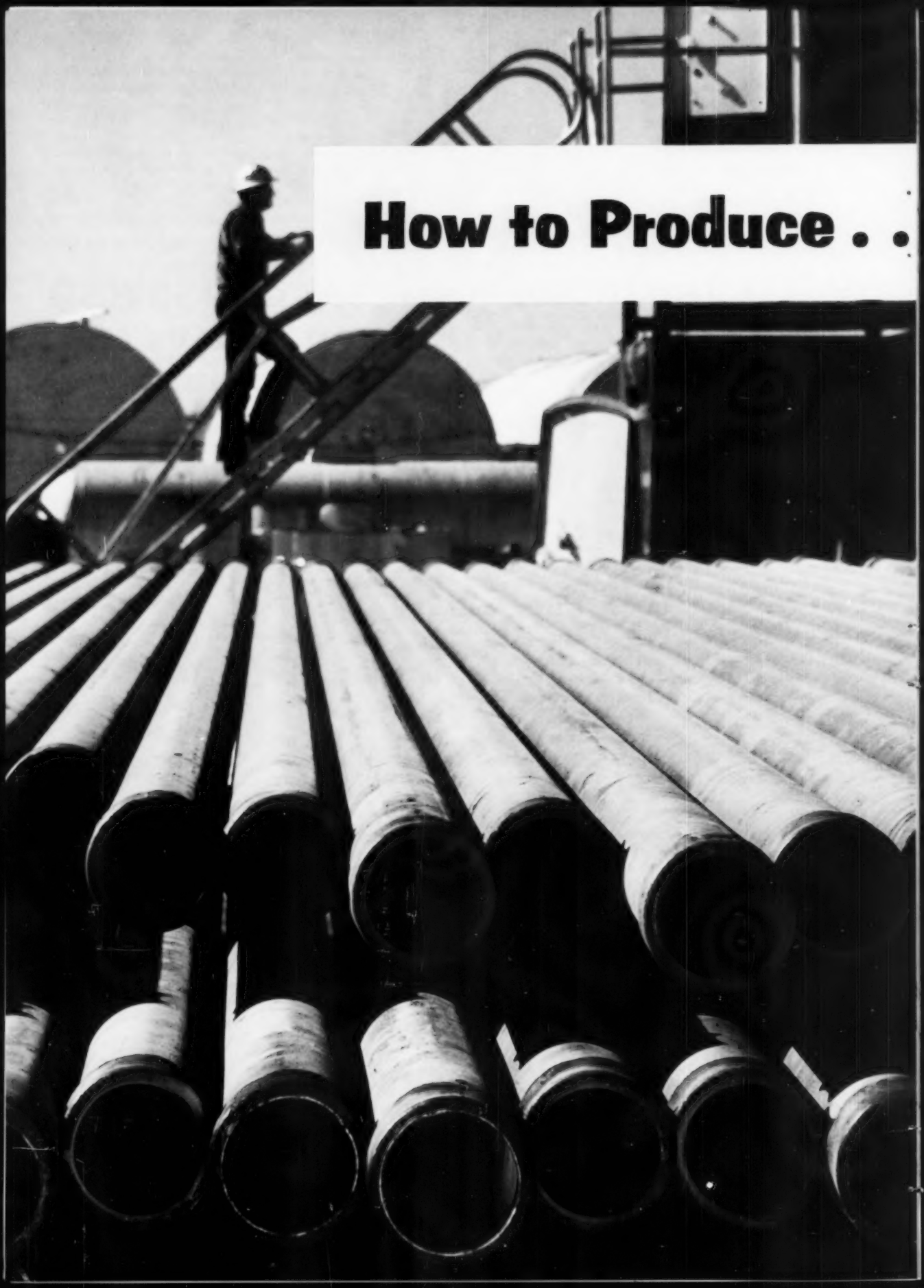

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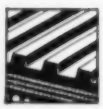
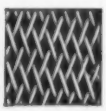
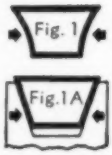


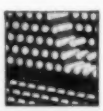
1. Stabilizing ribbed tops (U.S. Pat. 2548135) are exclusive with Gates. They dampen vibration, protect top of belt from damage, keep belt running smoothly over idler-equipped mud pump drives with no side whip.



2. Flex-Weave Cover (U.S. Pat. 2519590)
A Gates exclusive: provides greater flexibility with far less stress on fabric. Cover wears longer . . . increases belt life . . . more power available to driven machine.



3. Concave sidewalls (U.S. Pat. 1813698)
Concave sides (Fig. 1) increase belt life. As belt bends, concave sidewalls become straight, making uniform contact with sheave groove (Fig. 1-A). Uniform contact means less wear on sides of belt . . . far longer belt life.



4. Tougher, more resilient cords are able to absorb the severe pulsations of mud pumps; easily handle peak loads.

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2. The use of permeable plates and one grade only of fine filter media eliminates the possibility of a disrupted filter bed. Expense for maintenance, downtime and replacement of graded type beds is eliminated.

3. Permeable retaining plates prevent loss of fine filter media in filtered water and eliminate plugging meters, valves, and injection formations with filter media.

4. Permeable plates serve as flow distributors during backwash which distributes the backwash flow evenly from the entire bottom area of the filter. Complete suspension of all filter media washes the entire bed.

5. When loaded with filter media, the permeable plate filter weighs much less than many other types of filters thus requiring less foundation for support.

6. The overall height of the filter is less than other type filters by approximately 18 in.

7. The permeable underdrain plates are resistant to corrosion from water or chemicals used in cleaning the bed.

8. The pressure drop across the permeable plate is considerably less than the 24-in. of supporting bed of graded bed filters as shown in Fig. 2 and 3.

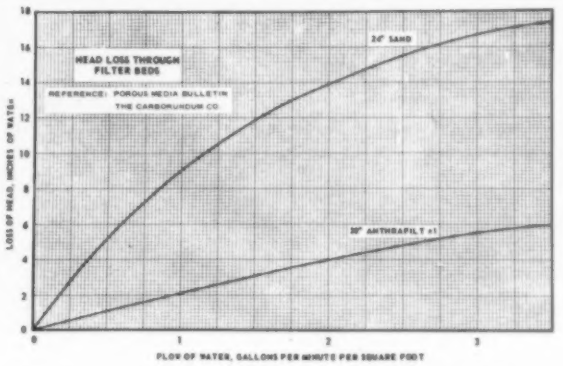
HEAD LOSS THROUGH FILTER BEDS
REFERENCE: POROUS MEDIA BULLETIN THE CARBORUNDUM CO.
24" SAND
30" ANTHRAFILT #1
LOSS OF HEAD, INCHES OF WATER
FLOW OF WATER, GALLONS PER MINUTE PER SQUARE FOOT

FIG. 2. Pressure drop for various rates of flow through a 24-in. sand bed filter and a 30-in. anthrafilt bed.

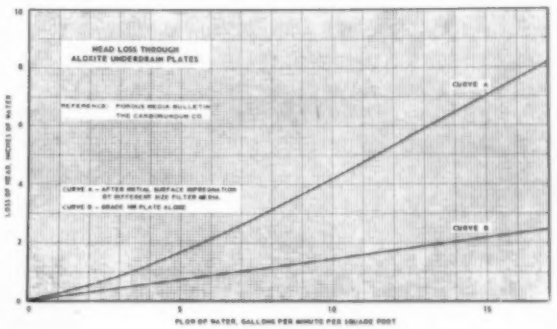
HEAD LOSS THROUGH ALOXITE UNDERDRAIN PLATES
REFERENCE: POROUS MEDIA BULLETIN THE CARBORUNDUM CO.
CURVE A
CURVE B
LOSS OF HEAD, INCHES OF WATER
FLOW OF WATER, GALLONS PER MINUTE PER SQUARE FOOT

FIG. 3. Pressure drop across permeable plate for two operating conditions. Curve A indicates flow characteristics after initial surface impregnation by different size filter media, while curve B is for the grade 160 plate alone.

Filter Media

Even though the term "sand" is generally used in the description of graded bed type filters, other types of filtering media are economically and effectively used in the filtration of brines and water, namely anthracite coal, sand, graphite gravel, carbon, excelsior, calcium carbonate, magnetic iron oxide, porous plates and tubes, terry cloth, and many more.

Numerous factors such as temperature, pressure, chemical characteristics of the influent water, type of media, all should be carefully studied before making a specific application.

Anthracite coal (anthrafilt), silica sand and granite gravel are predominant in the majority of industrial and water flood applications of gravity and pressure filters.

Filter sand. Natural sands used as filter media vary greatly in material, size and shape. The size and shape of sand grains will influence the compactness of the bed. Two terms, "effective size" and "uniformity coefficient" are used in comparing filter sands.

The effective size is defined as a grain size such that 10 percent of the particles are smaller and 90 percent of the particles are larger. The effective size is expressed in millimeters.

Variations in proportions of large and small particles are expressed by a uniformity coefficient. A grain size such that 60 percent of the sand is finer is determined. The ratio of this size to the effective size is called the uniformity coefficient. Ordinary natural sands have uniformity coefficients of 1.5 to 2.5.

The following specifications on filter sand was recommended by the Bureau of Mines and, in general, have been accepted as standard:

The filter sand should be clean, hard and resistant. It should be entirely free of clay, dust or organic matter. The sand should not contain more than 2 percent by weight, of calcium and magnesium taken together and calculated as carbonates. The effective size should not be less than 0.55 mm nor more than 0.60 mm. The uniformity coefficient should not be more than 1.8.

Specifications on filter gravel are the same as for the filter sand except for uniformity coefficient and effective size. Size and volume of sand and gravel for various sizes of graded bed filters are shown in Table 1.

The formation of "mud balls" or cementation of the sand grain is due to deposition of supersaturated calcium carbonate or iron salts. The occurrence of these "mud balls" are frequently found in sand beds.

Sand exhibits a tendency to dissolve in hot water (125 F or above) particularly in alkaline water; therefore, the use of sand is limited to lower temperature operations.

Anthrafilt. Anthrafilt is a screened and hydraulically graded filter media from selected anthracite coal. Size and volume of anthrafilt for various sizes of graded bed filters are shown in Table 1.

Anthrafilt being essentially a carbon is chemically inert. It does not coat with lime, iron salts, or manganese salts as does sand. These salts will precipitate on anthrafilt but they do not become cemented to the carbon particle. Backwashing easily removes these salts.

The specific gravity of anthrafilt is approximately 1.5 and a bulk density of 52.5 lb per cu ft while silica sand has a specific gravity of 2.6 and a bulk density of 100 lb per cu ft. Since anthrafilt is only one-half as heavy as sand, a lower backwash rate and less backwash water is required to clean an anthrafilt bed.

Anthrafilt grains are irregular in shape; therefore, do not pack as tight as sand grains which results in a lower pressure drop across the filter bed as shown in Fig. 2.

Porosity and greater surface area provides greater ability to entrap solids in the effluent water.

Filtering Rates

Several tests were made by the Bureau of Mines on pressure type filters with filtering rates for sand varying

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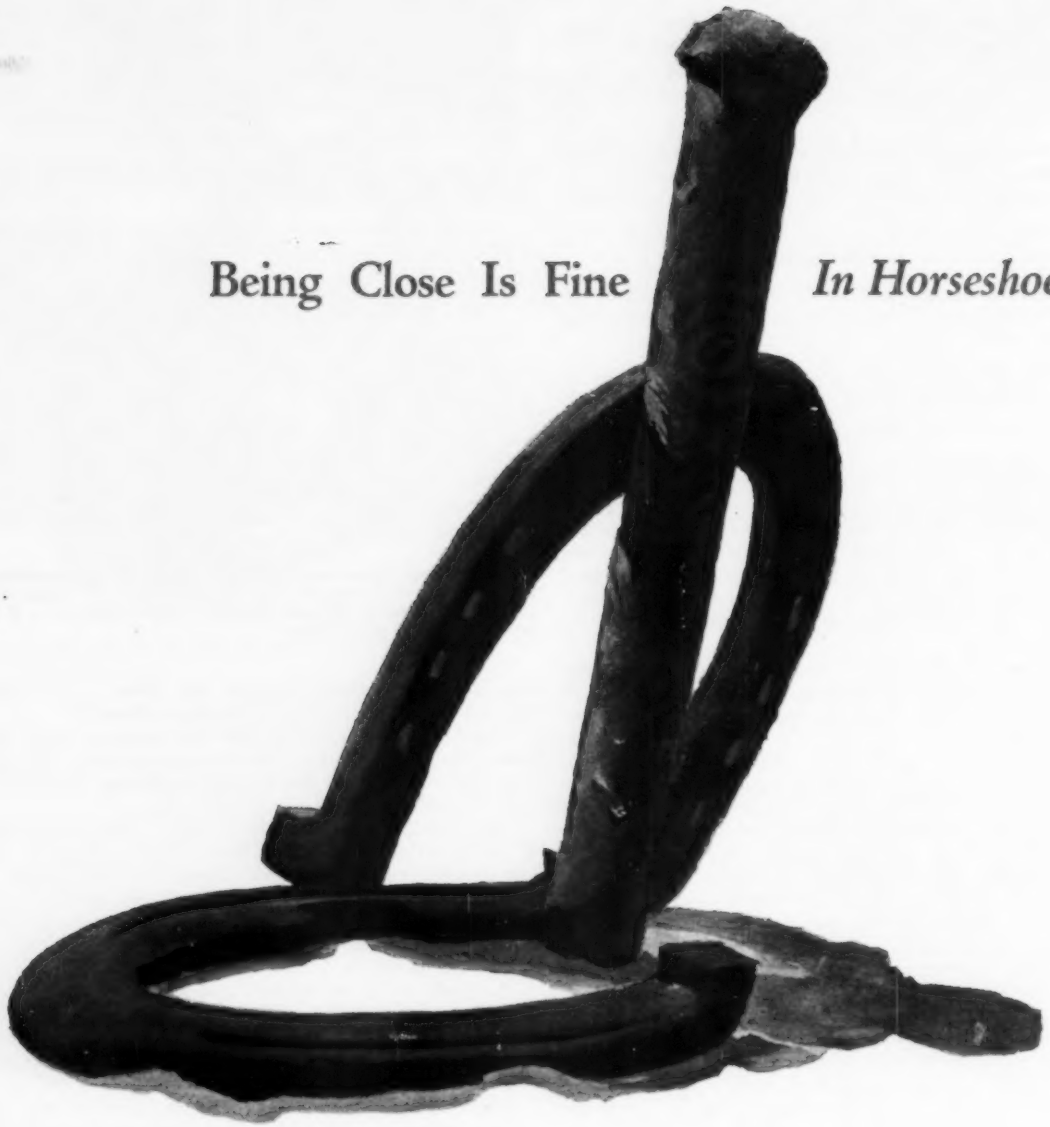

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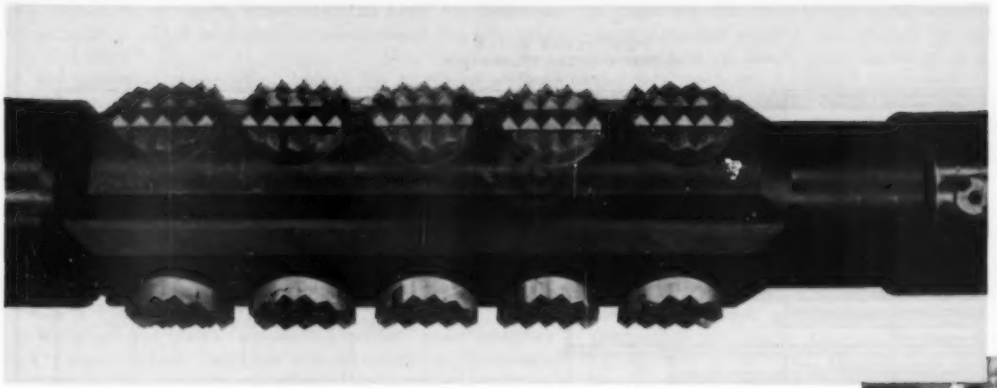
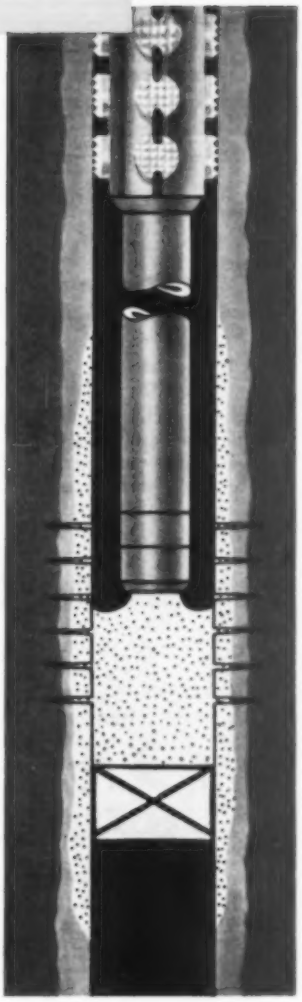


New Welex Wireline Cementer Provides Pin-Point Accuracy



Whatever your water problems—infiltration of the perforations, channels of communication, leaky casing or shoes, bottom-hole water — the new Welex *Wireline* Squeeze Cementing Tool provides the infinite accuracy and strict economy never before possible in squeeze cementing operations. The completely new and different wireline cementing tool gives more predictable results in increasing displacement, preventing cement contamination, eliminating tool movement during the pressurizing cycle, retaining pressure for a prolonged period of time, obtaining a satisfactory packer seal under high pressure and equalizing pressures following the squeeze.

Developed after extensive testing and field use, the Welex Wireline Squeeze Cementing Tool incorporates many new innovations which combine to make the tool a practical and economical operation in sealing off perforations, sealing off portions of a perforated section, sealing off portions of an open hole section and sealing off channels of communication.

The new Wireline Squeeze Tool offers advantages which are not possible with any other squeeze cementing tool: (1) use of rocket fuel with a retarded burning rate to create larger amounts of gas at higher temperatures; (2) a positive-sealing packer developed by Welex and not available anywhere else in the oil field; (3) a hydraulic anchor capable of holding more than 10,000 psi differential; (4) a trouble-free release mechanism by which pressure inside the tool and that of the hydrostatic head are equalized for easy recovery of the tool; and (5) a new type cement slurry developed by Welex decreases WOC time and stays in place after the operation is complete.

The new Welex Wireline Squeeze Cementing Tool is available from any Welex District Office in every major oil center. Call your Welex representative today for more information.

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Fort Worth, Texas

Division offices in Denver, Houston, Midland, New Orleans, Tulsa and Wichita.
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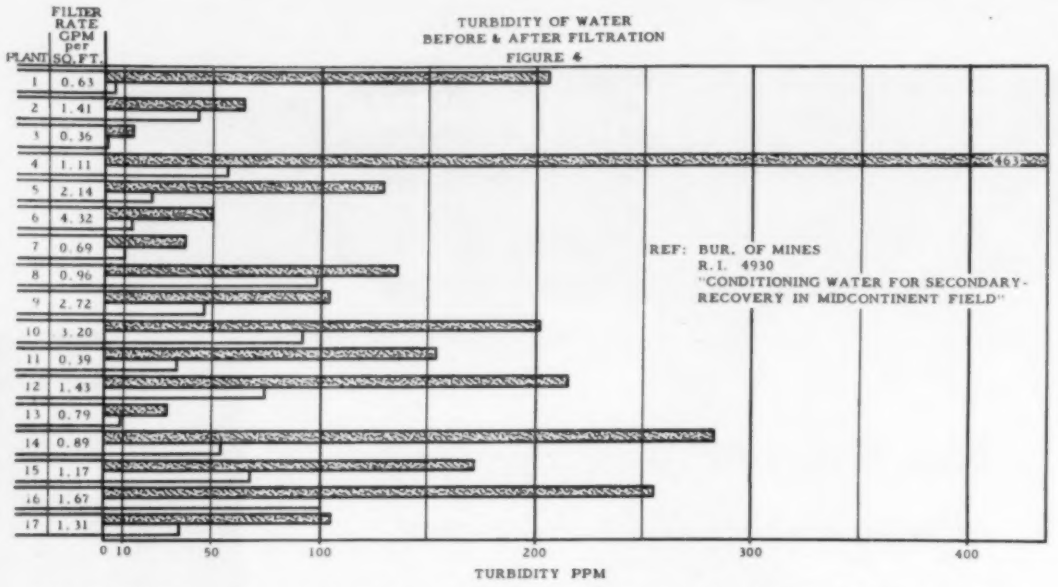


FIG. 4. Turbidity of water before and after filtration. Tests of 17 influent waters varied from 463 to 14 parts per million.

from 0.79 to 4.40 gal per min per sq ft of filter surface area. Based on those tests and recommendations, the filtering capacity of graded bed pressure filters and permeable plate pressure filters using sand as a filter media is based on a maximum filtering rate of 2.5 gal per min per sq ft of filter surface area for average conditions.

Maximum allowable filtering rates for anthrafilt filtering media are slightly higher than for sand. Light weight and angularity of filter particles results in less packing and greater porosity of the filter bed.

Based on field tests, the recommended filtering rate of permeable plate type filters using an anthrafilt filtering media is conservatively three gal per min per sq ft of filter surface area for average conditions.

Filtering rates are arbitrary and will vary from recommended values because of inlet conditions, type of water, quantity of undissolved solids, type and depth of filter media, condition of filter media, backwashing techniques. Overloading filters is a frequent mistake in field operations. Filter efficiency is hindered, life of filter is decreased, and maintenance cost increased due to replacing filter media more often.

When filters are operating with intermittent flow, or "on-off" production, the filtering rate should be determined at maximum flow or throughput of water through the filter for a short interval of time and should not be based on daily production records.

When installing several filters, flow should be controlled and evenly distributed among the filters. Filter beds do not have the same pressure drop, therefore the filter with the smallest resistance to water flow will receive the largest water load. Therefore, due to the increased filtering rate, which may exceed 2 to 3 gal per min per sq ft, the filter may soon become fouled by the small particles penetrating through the bed. As one filter is fouled, and the resistance to flow increases, the next filter will receive an excessive water load and may eventually become fouled if the small suspended particles cannot be removed by backwashing.

Rate of flow indicators or controllers should be installed on each filter to insure an equal filtering load for each filter, which may eliminate the cost of replacing filter beds which become fouled by overloading.

Application of Filters and Oil Skimmers

The primary function of an oil skimmer is to remove final traces of oil that may be entrained in the water after primary separation of oil and water in a free water knockout or treater. Water leaving the oil skimmer should be free from oil and may be discharged into the Gulf or ocean or may be passed into a filter.

The design of most oil skimmers is based on the removal of all oil particles 150 microns or larger in diameter. However, in most cases, smaller oil particles will be removed. Oil content of water determined by the Ether Extraction Method gives oil in parts per million (ppm). This is misleading in treating water for injection purposes as this method determines the total oil content, some of which is soluble in water and cannot be removed by

TABLE 1. Filter Specifications for Graded Bed Filters.

Depth of bed	Size of Filter Media: Sand & Gravel	Size of Filter Media: Anthrafilt	Filter Shell Size: Volume of Filter Media used (Cu Ft) 4 x 5	5 x 5	6 x 5	7 x 5	8 x 5	10 x 5
24"	Filter sand	#1 0.6-0.8 mm	25	39	56	76	100	156
6"	Gravel-3/16" to 1/4"	#2 3/32" to 3/16"	6	10	14	19	25	40
6"	Gravel-3/8" to 1/2"	#4 5/16" to 9/16"	6	10	14	19	25	40
6"	Gravel-3/4" to 1"	#5 9/16" to 13/16"	6	10	14	19	25	40
6"	Gravel-1" to 2"	#6 13/16" to 1 5/8"	6	10	14	19	25	40

TABLE 2. Analysis of Oilfield Brines in Parts Per Million (ppm).

Area	S. W. Kansas	W. Kansas	Illinois	Texas	Oklahoma
Total solids	57,020	241,200	101,899	8,384	141,032
Calcium	3,120	13,100	3,000	166	7,112
Magnesium	1,203	3,560	1,378	43	1,979
Sodium	13,050	65,340	34,620	2,989	44,613
Bicarbonate	354	29	110	307	67
Sulphate	2,380	115	0	148	372
Chloride	27,150	133,930	62,640	4,680	86,875
Bromide	96	615	124	—	—
Iron	—	—	25	—	14
Carbonate	—	—	—	51	—
Specific gravity	—	1.073	1.005	—	1.100

oil skimmers or filters. Therefore, the basis for determining removal of oil is usually a visual check for coloration or "oil slick."

By removing traces of oil before the produced water is forced through valves and fittings by the transfer pump, emulsification of the small oil particles is prevented. Oil skimmers recover this oil which can be returned to stock and remove the oil from the influent water to the filters, thus reducing its turbidity.

Removal of turbidity. Turbidity of water is due to suspended matter, "undissolved solids," is a finely divided state, such as clay, silt, silica, organic matter, microscopic organisms, iron compounds, emulsified oil and similar matters.

Although the terms "suspended matter" and "turbidity" are closely allied, they are not synonymous. Suspended matter is the quantity of material in a water which can be removed by filtration. Turbidity is a measurement of the optical obstruction of light passing through a water sample as compared with an arbitrary standard turbidity scale. The standard unit of turbidity is that produced by one part per million (ppm) of insoluble silica (SiO_2) in distilled water. Thus, a water having a turbidity of 10 ppm as SiO_2 means that the obstruction of light through this particular water is equivalent to the obstruction of light by a sample of distilled water containing 10 ppm of insoluble silica.

Turbidity can be interpreted as a lack of clearness or brilliance in a water, but should not be confused with color. A water may be dark in color but still clear and not turbid.

How to measure turbidity. Although there are several types of turbidimeters available for measuring turbidity, a photo-electric type is the most sensitive and gives the most accurate results. Air should be excluded from the sample and readings made as soon as possible after the samples are taken to assure consistent and accurate data.

Turbidity of influent water. Turbidity of the influent water to a filter depends entirely upon the composition of the water and the type of water, whether it is produced water, supply water from a water well, or water from surface streams and wells. In Fig. 4, turbidity of the influent water of 17 tests varied from 463 to 14 ppm. Some typical analyses of oilfield brines are shown in Table 2.

Turbidity of effluent water. The degree to which water for injection must be conditioned will depend entirely upon the system or disposal formation. Some disposal formations are highly permeable, thus little conditioning or filtering is required. However, if the disposal formation is of low permeability, high surface pressures may be required for injection and a more elaborate method of conditioning or filtering may be necessary to deliver a comparatively stable brine, free of suspended matter, to the injection well.

The degree of filtration depends on the composition of the influent water, type and depth of filter media, frequency of backwashing, proper backwashing rate for the filter media used, presence of oil, presence of air, and economical considerations. The turbidity of effluent water from filters of the 17 tests shown in Fig. 4 varied from 0 to 100 ppm. It must be noted that there is no correlation between influent and effluent water on filtering rates.

TO BE CONTINUED

Part 2 "Techniques of Backwashing and Operating Filters" will be published next month.

Dependable

HERCULES STUFFING BOXES end Your pumping worries*

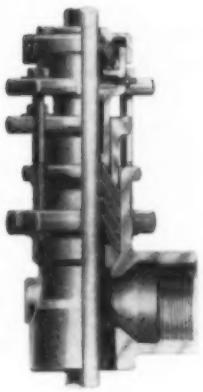
HERCULES Duplex Polished Rod Stuffing Boxes are constructed from high grade malleable iron (55,000 PSI Tensile Strength) and are rated 3,000 pound test. Flexibility and the cone-shaped Packing Rings are the combination of factors which make the HERCULES Stuffing Box without equal for any pumping situation.

HERCULES OIL RESERVOIR UPPER GLAND

**Any HERCULES Stuffing Boxes may be equipped with Oil Reservoir Upper Glands on "problem" wells which pump-off and burn packing. The polished rod moves through the oil in the reservoir which lubricates and cools it.*

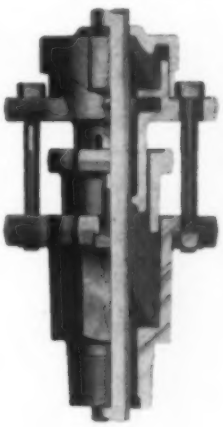
"TEE TYPE" DUPLEX POLISHED ROD STUFFING BOX

HERCULES "TEE TYPE" Stuffing Box is very compact, only 15" high. It is full opening which allows rods to be run or pulled without removing Stuffing Box body. It is furnished in 2", 2½" and 3" sizes with any API Tubing or Line Pipe Thread.



"REGULAR TYPE" DUPLEX POLISHED ROD STUFFING BOX

The old reliable; tried and proved on thousands of wells from coast to coast and in many foreign fields.



"TYPE DP" DUPLEX POLISHED ROD STUFFING BOX

A double packed Stuffing Box for use on high pressure wells and those that flow intermittently. Especially desirable for wells located near buildings, fire hazards or growing crops. Two compression bolts, in bottom sections, are tightened on lower packing set while replacing packing in upper section. Possess same flexibility as the regular and Tee base type.

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Maintaining equal distribution of the cement slurry pumped into the well is the important part of oil well cementing . . . cementing that helps provide your well with maximum long-lasting protection against the dangers of corrosion, contamination and blowout.

That's why your Halliburton cementing job is performed with specially-developed tools designed to provide uniform annulus area . . . to aid in preventing channeling of cement behind the casing . . . to facilitate better bonding of the cement . . . and to help extend the producing life of your well.

Halliburton's uniform custom-controlled cementing helps provide maximum protection for your well and maximum protection of the investment that you have in it. For all your oil well cementing requirements, call HALLIBURTON, the organization with more down hole cementing experience than any other company in the industry.

NOTE THE FEATURES OF THESE HALLIBURTON TOOLS DESIGNED FOR BETTER WELL PROTECTION . . .

S-3 CASING CENTRALIZER

HALLIBURTON'S S-3 CASING CENTRALIZER

The S-3 Casing Centralizer, with heat-treated lap-welded springs, minimizes channeling, aids in uniform placement of cement around casing. Designed to give positive centering even under the most difficult conditions. Hinged for quick, easy installation as casing is run. Heavy Duty and Slim Hole Centralizers available for special applications.

HALLIBURTON'S VISE-LOK LIMIT CLAMP

A new method of installing Recipo Wall Cleaners, Casing Centralizers and Cement Baskets on casing at selected spacing without welding of lugs or other limiting devices. Locking force is created by special file-hard gripping disc slips inside the precision forged steel ring and forced against the casing by taper pins driven in from behind. Hinged design for easy installation.

HALLIBURTON'S SOLID SET SCREW LIMIT RING

Another economical and dependable method of installing auxiliary equipment on casing without welding lugs or rings. The Solid Set Screw Limit Ring does not equal the load-carrying capacity of the Vise-Lok Limit Clamp, yet its performance surpasses most other makes of non-weld limit rings or stop collars.

SOLID SET SCREW LIMIT RING

VISE-LOK LIMIT CLAMP

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TWO EFFICIENT TYPES OF WALL CLEANERS TO INCREASE CEMENTING EFFECTIVENESS...

HALLIBURTON'S NEW ROTO WALL CLEANER

Cleaner formation surfaces and better cement bonding are made possible when this sturdy rotating cleaner is used. The Roto Wall Cleaner is better for efficient mud cake removal, reduces vertical channeling and decreases the hazards of bridging in the annulus... aids in a more uniform distribution of cement.

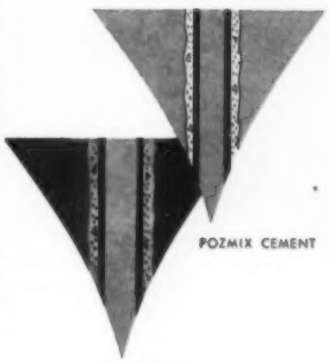
HALLIBURTON'S NEW RECIPO WALL CLEANER

A most useful tool for the removal of filter cake from wall of hole to allow better bonding of cement to formation and casing. Wide, flexible, tough rubber fingers clean more bore hole area, minimize hole damage and aid in breaking up channeling of cement when casing is reciprocated. Wide fluid passage between cleaning fingers help reduce circulating pressures and bridging action of filter cake cuttings in the annulus.

HALLIBURTON'S "POZMIX" CEMENTS FOR LONGEST LASTING WELL PROTECTION...

HALLIBURTON'S POZMIX CEMENT

This top performance cement is far superior to conventional portland cements and improves resistance to sulfate and salt water corrosion. Pozmix Cement is also lower in cost, easier to pump, easier to perforate, less permeable and more durable. It has an enviable record of success in thousands of cementing jobs. A wide variety of chemical additives provides precision control for a wide range of cementing applications.



HALLIBURTON'S POZMIX 140... THE LEADING CHOICE OF THE INDUSTRY

Developed for use in deep hot holes, where temperatures range from 140°F to 400°F and higher, Pozmix 140 is excellent for long strings and liners. Consists of Pozmix, lime and set control additives that meet individual well requirements. Sets to a dense durable product that provides year-after-year casing protection.

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284 SERVICE CENTERS...
JUST MINUTES AWAY FROM YOUR WELL

RUNNING TOUR with MEN in the INDUSTRY

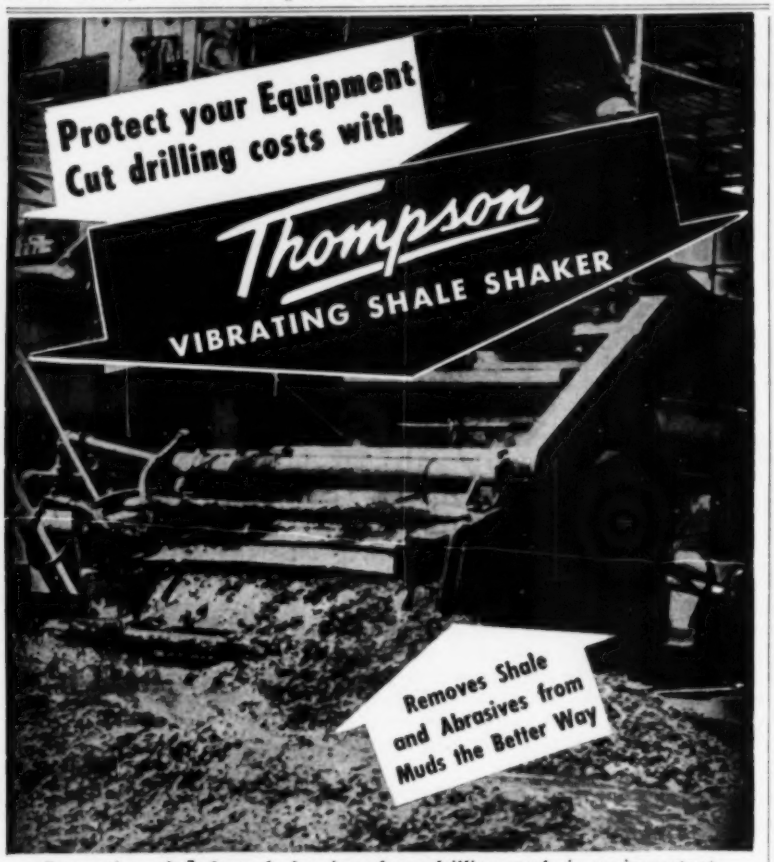
▸ Lone Star Producing Company, wholly-owned subsidiary of Lone Star Gas Company, elected three new directors at their annual meeting. They are **Louis G. James, Willard G. Wiegel** and **Carl M. Hill.**

Each is an officer in the parent gas company and of Lone Star Producing Company. James is executive vice president (finance and accounting), Wiegel is vice president (personnel) and treasurer, and Hill is vice president (exploration and gas supply).

Carry-over directors of the producing company are **D. A. Hulcy,** Lone Star board chairman; **L. T. Potter,** president; **E. A. Brown,** executive vice president (operations) and **Julian L. Foster,** vice president in charge of the transmission division.

▸ **A. Carl Tutschulte** has been promoted to divisional petroleum engineer of Tidewater Oil Company's western division. He replaces **Roy S. Curl** who retired after 36 years of service with the company. Prior to his present appointment, Tutschulte was assistant divisional petroleum engineer with headquarters in San Francisco. **Arthur M. Mouser** has been named assistant manager, gas utilization department.

Albert S. Trube Jr. succeeds Mouser. He was formerly chief reservoir engineer.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VIBRATING SHALE SHAKER
Removes Shale and Abrasives from Muds the Better Way

Separation of shale and abrasives from drilling muds is an important *must* for an effective, time-conserving, money-saving drilling job. Reclamation of mud is vitally important. No matter what the mud flow or well depth may be, a THOMPSON Vibrating Shale Separator and Sample Machine stands up to meet any demand. It's field proven! *You get clean mud.* THOMPSON Separators are self-motivated... making tools last longer... with a minimum of re-tooling and restoration of mud solution.

A THOMPSON Separator is your surest bet.. for shallow, medium and deep wells. The dependable Sample Machine works simultaneously with the Separator, giving a foot-by-foot mud analysis with specimens. *Write for Free Folder.*

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Martin H. Mitchell has been appointed general manager of Tidewater Oil Company's operations in Pakistan. Mitchell previously served as general manager of Tidewater's exploration and production operations in Turkey.

▸ **Jack H. Abernathy** has been named president of Big Chief Drilling Company, succeeding **William T. Payne** who has been appointed chairman of the board of directors. Other new appointments at Big Chief Drilling Company include: **Sidney V. Hodges,** senior vice president and director, and president of Columbia Oil Company, a Big Chief affiliate; **F. E. Godfrey,** director and treasurer; and **Ted C. Findeiss,** secretary and attorney. Abernathy, a graduate of the University of Oklahoma, was 1957 president of the American Association of Oilwell Drilling Contractors and has long been active in API production activities.

J. H. Abernathy

R. E. Williams

▸ **Ross E. Williams** has been appointed assistant to the vice president and general manager of domestic and foreign crude oil production for The Atlantic Refining Company. He succeeds **A. B. Macaulay,** who has been named as the new manager for the company's Oklahoma-Kansas producing region. Williams was formerly chief accountant.

▸ **B. B. Miller,** Ohio Oil Company, has been appointed assistant to the president. He formerly was superintendent of the company's Robinson, Illinois, refinery. He succeeds **R. M. Churchwell,** who becomes manager of foreign operations. **G. R. Schoonmaker,** former assistant manager of foreign production, becomes manager of foreign exploration. **Carl M. Decker,** controller of the Oasis Oil Company of Libya, located in Tripoli, has been appointed general auditor in the auditing division of Ohio Oil. **Lewis J. Qualkenbush,** assistant supervisor of the production accounting department will replace Deckard in Tripoli.

▸ Cable Engineering, consulting petroleum engineers, Wichita Falls, Texas, has changed its name to Cable & Stephens. Partners are **Jo H. Cable** and **Fred Stephens.** The firm has been active in consulting petroleum engineering for more than 30 years.

Fred Stephens

C. A. Houy

▸ **Carl A. Houy** has been elected to the board of directors and named vice president, drilling and production, of Vista Petroleum Corporation. He is also executive vice president of Bel-air Oil Company.

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When you are faced with the question "Will it make a producer?", the Schlumberger Formation Tester gives the answer.

From the soft sands of the Coastal Areas to the hardrock country of the Mid-Continent, more than 3,000 successful tests have given clear decisions — *each test pin-pointed exactly in the interesting section shown by the log.*

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ONLY SIKORSKY HELICOPTERS ARE FULLY PROVED IN HEAVY-PAYLOAD COMMERCIAL SERVICE

Only Sikorsky helicopters have thoroughly proved their versatility and reliability with years of commercial service carrying heavy loads.

Shuttling crewmen and supplies to offshore oil rigs, eliminating expensive and time-consuming road-building through jungles or mountains, or in countless other demanding jobs, Sikorsky S-58s and S-55s have speeded the operations of a number of vital industries.

Sikorsky helicopters have performed such varied tasks as pouring concrete from the air, placing heavy steel transmission towers into position . . . airlifting drilling rigs with personnel and supplies into jungle sites . . . or moving quantities of heavy machinery to factory rooftop operating positions.

If conventional transportation is inadequate where you want to operate, Sikorsky helicopters may provide the answers to your problems. They offer a unique and thoroughly proved capability to go wherever you need to go, carrying worthwhile payloads. Write for complete information.

POURING CONCRETE—A Sikorsky S-58 prepares to pour a 2700-lb. load of ready-mixed concrete for tower footings for a high-voltage line in California. The S-58 saved time and costly road building by also flying steel towers into position at the inaccessible sites.

Photo: *The British Petroleum Co., Ltd.*

JUNGLE DUTY—In remote areas Sikorskys offer unmatched versatility in serving many vital operations. In New Guinea, for example, 3 S-58s speed the search for oil by transporting drilling rigs, workmen, and all equipment and supplies.

SIKORSKY AIRCRAFT
STRATFORD, CONNECTICUT
One of the Divisions of United Aircraft Corporation

Frank Lindeman Jr., former vice president-production for Pan American Petroleum will establish offices in Tulsa as a consultant to the petroleum industry, specializing in general production practice, operational problems, engineering work, secondary recovery project, gas development and sales and other aspects of industry activity.

Frank Lindeman Jr.

T. O. Allen

Thomas O. Allen, former senior supervising petroleum engineer with Humble Oil & Refining Company, has become manager of the newly formed drilling and development division of Jersey Production Research Company in Tusla, Oklahoma.

Dr. Sylvain J. Pirson, a University of Texas petroleum engineering professor, will lecture on oil reservoir engineering, in France, England and Italy this summer and will visit and consult with oil company officials in Belgium, Holland and Germany. Pirson was formerly a special research associate for Pan American Petroleum Corporation in Tulsa.

J. C. Cody, vice president in charge of drilling and production, has elected to retire effective November 1, 1958. Cody will have completed over thirty-eight years of employment with The Superior Oil Company on this date.

Charles F. Bedford has been elected vice president in charge of production and a director of Pan American International Oil Company, a wholly owned subsidiary of Pan American Petroleum Corporation. He was formerly general superintendent, producing department, for Pan American Petroleum in Tulsa. He has assumed his new duties at the New York headquarters of the international firm. **J. D. Wells** has been named chief production engineer for Pan American International Oil and will be assigned to the firm's New York office. Wells is assistant to the chief engineer. **C. Clark Fuller Jr.** has been named staff engineer and will also be assigned to the New York office. He is petroleum engineer, senior grade, for Pan American Petroleum.

Shell Oil Company announced today the following personnel changes in their New Orleans exploration and production area: **A. C. Dahl,** presently division production manager, Lake Charles division, to division production manager of the new Lafayette production division. **A. R. Newman,** present division production manager of the Franklin division to division production manager of the Delta division, Westwego, Louisiana. **A. T. Eyler Jr.,** division production manager of the Delta division to New Orleans as area chief exploitation engineer. **C. J. Ward,** New Orleans area chief exploitation engineer, to New York as head office senior exploitation engineer. **W. E. Harpst,** New Orleans area chief mechanical engineer, to New York as manager head office mechanical engineering and **J. E. Gallagher,** New York, will replace Harpst in New Orleans. **F. D. Leigh,** senior mechanical engineer in head office, to division production superintendent of the company's marine production division in New Orleans. **Dr. R. D. Miller** has been appointed manager of the new technical information services department, **S. L. Pease** will be manager of the training department and **D. E. Broussard** will be manager of the service engineering department. Miller has been serving as area geophysicist in Shell's Midland area, Pease is currently coordinator of technical training in the technical services division and Broussard has been a senior engineer in the exploration and production research division.

John Ryan, formerly Midland district exploration supervisor of Delhi-Taylor Oil Corporation, is going to Australia to act as exploration supervisor for the company's new subsidiary, Delhi Australian. **John Castle** will advance to the position formerly held by Ryan in the Midland district.

W. H. Drushel has been appointed general superintendent of drilling and production, South Texas division of The Texas Company's domestic producing department, succeeding **R. B. Leggett,** who has retired. Drushel was previously assistant general superintendent in the division.

Hugh L. Riley has been named superintendent of the Oklahoma production division of Cities Service Oil Company. **E. E. Ives,** long-time superintendent of North Oklahoma operations, has retired. The division now is being re-aligned to include all of Oklahoma. Included are operations supervised from the district office at Ponca City under **E. D. Blackburn,** at Lindsey under **J. W. Wise,** and at Oklahoma City under **R. L. Higginbottom.** Cities Service announced the assignment of **Robert L. Jones** of Houston tao new duties in the development of technical data in the Cities Service program of producing average acquisition. **George Field,** assistant division geologist for Cities Service at Houston, will succeed Jones as division geologist there. Jones brings to his new job 30 years of geological experience with Cities Service and Field has been on the geological staff since 1936.

Kenneth W. Paul, a geological engineer, was named to the position of manager, lease and oil properties evaluation department of Mayflo Oil Company, a Texas corporation.

From 1954 to 1957, he served Shell as a geologist in the technical services division, and as marine geologist. Since March of 1957 Paul has been consulting geological engineer with H. Zinder and Associates, of Houston.

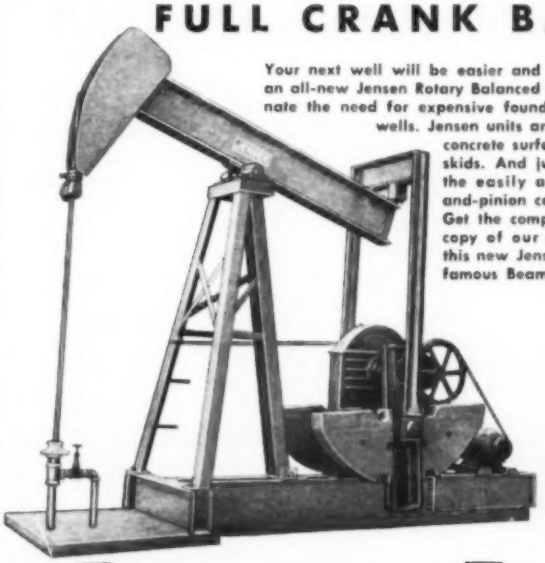
Thomas C. Borland was elected vice president-production and a director of Pan American International Oil Company. **Jack W. Hamilton** will be resident manager at Tehran, Iran, for Pan American International.

Borland succeeds **Charles F. Bedford,** who has been recalled to Tulsa to become vice president-production and a director of Pan American International's parent company, Pan American Petroleum Corporation. He moves to New York from Calgary, Alberta, Canada, where for the past three years he has been assigned as division production superintendent for Pan American Petroleum's Canadian division.

The New JENSEN Rotary Balanced JACK offers:

COMPLETE FLOOR CLEARANCE

FULL CRANK BALANCE



Your next well will be easier and less costly to equip with an all-new Jensen Rotary Balanced Pumping Jack. You eliminate the need for expensive foundations and crank weight wells. Jensen units are quickly installed on flat concrete surfaces or on simplified steel skids. And just one man can operate the easily adjusted, full crank rack-and-pinion counterbalance.

Get the complete story. Send for your copy of our catalog, fully describing this new Jensen Rotary Series, and the famous Beam-Balanced Line. A call or letter will bring it to you — quick!

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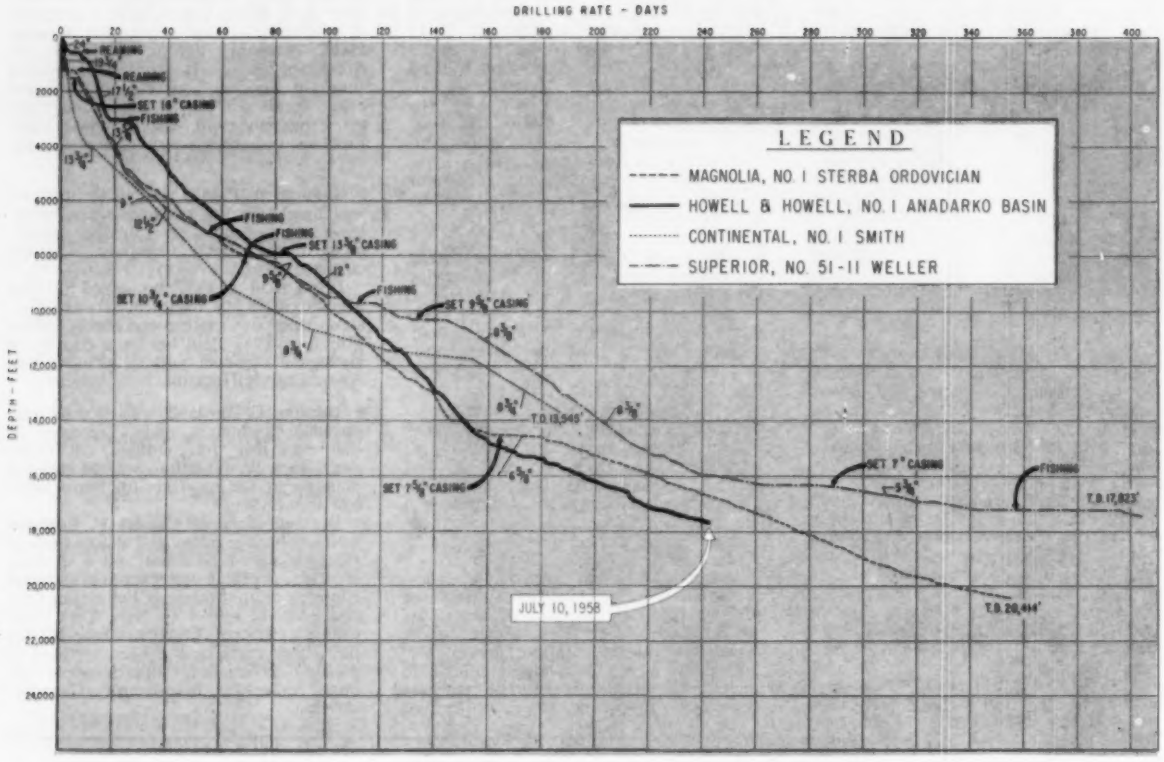
PROGRESS REPORT NO. 5

Anadarko Basin No. 1
Caddo County, Oklahoma



CASING CEMENTED IN OKLAHOMA DEEP TEST

AT 247 DAYS AFTER SPUD-DATE, Howell & Howell has run and cemented the intermediate casing string in its Anadarko Basin No. 1, the Caddo County, Oklahoma, deep test planned to drill to 24,000 ft. (*The Petroleum Engineer*, March 1958, page B-31.) The casing was run as a liner from 7324 ft to 17,447 ft in 12-in. hole.

Hole Record

The well was spudded on November 10, 1957, with a 24-in. hole which was drilled to 540 ft. A string of 20-in. OD, 72.16 lb-per-ft line pipe was run and cemented to the surface. A 17½-in. hole was then drilled to 7903 ft and cased with a special string of 13⅜-in. OD, N-80, 85 lb-per-ft casing. Drilling then continued with 12-in. hole to 17,682 ft before the intermediate string of 9⅝-in. casing was run.

Casing String

The liner, which was run on a string of 4½-in. pipe, consisted of 247 joints of 9⅝-in., P-110, 42.7 lb-per-ft, flush joint lines with associated hanging equipment. Differential float equipment consisted of a float shoe and a float collar run one joint above the shoe.

Cementing Job

After the liner was run and hung from 7324 ft to 17,447 ft, it was cemented with 2997 cu ft (1185 sacks) of a light weight additive blend with portland cement and 0.43 percent low water loss additive, 1100 cu ft (715 sacks) of pozzolanic cement, and 100 sacks of slow-setting cement.

Cement mixing operations were begun at 3:42 a.m. on July 15 and were completed by 4:50 a.m. Cement was then pumped and the plug was landed at 6:12 a.m. During pumping, the average circulating pressure was 1100 psi. After the plug was landed, it was tested to 1700 psi. The liner setting tool was then pulled from the setting sleeve and an estimated 60 bbl of cement were circulated out of the 13⅜-in. casing string.

The first batch of cement (1185 sacks) weighed 12.4 lb per gal, the pozzolanic cement was mixed 13.7 lb per gal, and the slow-setting cement weighed 15.5 lb per gal.

Further Drilling

Drilling is continuing in the Anadarko Basin No. 1 with 8⅝-in. hole planned to total depth. Operators are confident that their equipment has already been proved capable of reaching the 24,000-ft target depth without difficulty.

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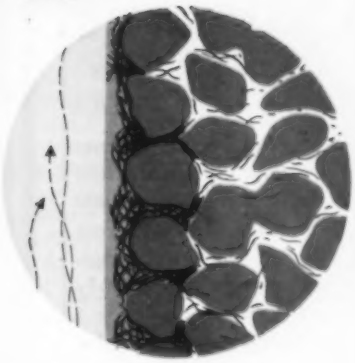

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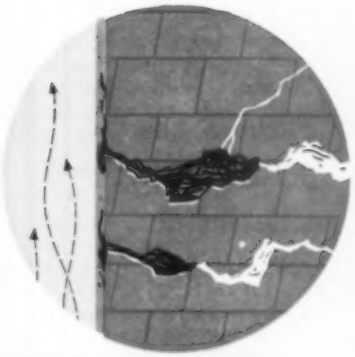
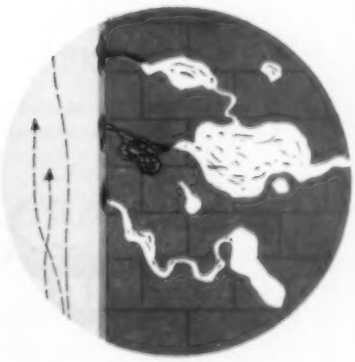


FRACTURES OR FISSURES



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Personals

L. C. Ritts Jr., has been appointed to the newly-created position of manager, exploration operations, for Pan American Petroleum Corportion in Tulsa.

Ritts has been serving as division exploration superintendent for the Texas-Louisiana Gulf Coast division of Pan Am in Houston, where he will be succeeded by **John C. Johnston,** who formerly held the same position in Pan Am's Rocky Mountain division at Casper, Wyoming. **Leland C. Adams,** who has been district exploration superintendent at Lafayette, Louisiana, replaces Johnston at Casper.

C. L. Franke has joined Plymouth Oil Company as regional production superintendent in the company's office at Calgary, Alberta, Canada. He formerly was employed as chief engineer for Pacific Petroleums, Ltd. **Don E. Fisher Jr.** has joined Plymouth Oil as an attorney in the company's headquarters in Sinton, Texas. Fisher resigned from the employee relations department of the Fort Worth production division of Gulf Oil Corporation to accept his new position.

Albert B. Stevens, formerly general manager of Farnsworth & Chambers Oil Company has purchased the companies producing properties in West Texas. He has established the firm of Albert B. Stevens & Associates, with offices in the San Jacinto Bldg., Houston, Texas, to operate these properties and to engage in oil and gas property evaluation and management.

William D. Stuart has been appointed as executive assistant to the general manager of the Canadian Petroleum Association. Prior to joining the association staff, Stuart was a member of the land department of Imperial Oil Limited in Calgary. **James M. MacNicol** was appointed as statistician for the association. MacNicol has been engaged in the marketing departments of Canadian Petrofina Limited and Royalite Hi-Way Ltd.

Floyd Brett, has been appointed manager of the Tusla division of Sinclair Oil & Gas Company. He succeeds **W. R. (Dick) Thixton,** vice president and manager of that division, who retired. Brett was elected a Sinclair vice president in August 1956, and was manager of the Midland, Texas, division. **George D. Almen Jr.,** formerly of Houston, and also a company vice president, become manager of that division. Thixton retired from Sinclair after almost 25 years of service.

John Sidney Smith, public relations director for Sun Oil Company, has been named to direct the employee program in Texas for the Texas Oil Information Committee of the American Petroleum Institute. He succeeds **A. B. Macauley,** transferred to a new assignment with The Atlantic Refining Company at Tulsa.

Victor V. Graf has been appointed assistant to the president of Seismograph Service Corporation. He was formerly manager of research, engineering and supply for Seismograph Service Limited in England.

Ralph J. Schilthuis, vice president and director of Humble Oil & Refining Company, has been awarded a Colorado School of Mines Distinguished Achievement Medal. An alumnus of the school, he also delivered the keynote address at the recent 24th Annual Engineers' Day program.

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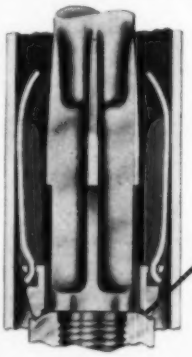

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EXPLORATION ACTIVITIES

Eighter from Decatur . . .

Wise County Leads North Texas Activity

Southern Union Gas Company has opened a new Strawn sand pool four miles southwest of Decatur. The company's Womack Unit No. 1 in P. Ryan Survey A-705 flowed 130 bbl of 39.2 deg oil on 24-hr potential test from Strawn sand section perforated with 4 shots per ft at 3640-48 and 3652-62 ft. Gage was recorded through 26/64-in. choke, with tubing pressure reading of 130 psi, casing pressure 298 psi and gas-oil ratio 1970 to 1. Total depth is 6250 ft.

The well is scheduled to be dually completed later from an Atoka Conglomerate section near 5400-6100 ft where it tested approximately 6,000,000 cu ft of gas per day, and that Southern Union plans to spud in soon about 1¼ miles to the east in an effort to determine the extent of the new structure. The second test will be designated Womack Unit No. 1-B.

Activity in Wise County has been strong since FPC approval of a gas line in 1956 to take gas from the area to Illinois markets. Natural Gas Pipe Line Company of America, owner of the line, agreed to take gas from wells from a group of independent companies led by Christie, Mitchell & Mitchell of Houston. Additional looping and gathering facilities are under construction at present and gas well expansion is still in progress.

The discovery of natural gas in Wise (in Bend or Atoka conglomerate) was accompanied by discoveries of oil in the Caddo formation and in the more shallow Strawn sand. A strong play for Strawn oil has developed that has extended throughout Wise County, into Jack County and is now pointing to Parker County.

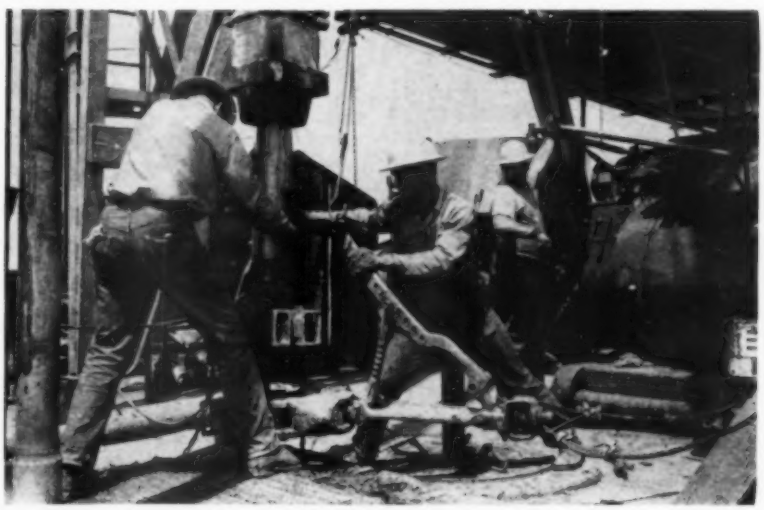
Combined oil and gas drilling in the past eighteen months has been far above previous levels. George Mitchell, partner in the Christie, Mitchell & Mitchell group, cites that "The firm has increased personnel 150 since they started in Wise County — including those in the Wiseco gas processing plant." The company drilled approximately 110 wells last year; 100 of which were in Wise County. They farmed out an additional 100 wells.

Trice Drills Harris County Test

A 7500-ft test of the Upper Yegua sand has been staked by Trice Production Company's Texas Gulf Coast district, on a 900-acre block 17 miles west of Houston and two miles northeast of Addicks in Harris County.

The test is the No. 1 Plummer, 2½ miles southwest of oil production in the Addicks field. The wildcat is north of Katy Highway (U. S. 90) in the G. W. Toliver survey, A-761.

More oil for North Texas' gas county. This is the drilling crew of John W. Harris Drilling Company, Wichita Falls, in action at Southern Union Gas Company's Womack Unit No. 1 just prior to completion of the well as a new Strawn sand oil discovery in Wise County.



CALIFORNIA

2520-Bbl Well Opens San Emidio Nose Field

Richfield Oil Corporation has opened the San Emidio Nose field, in the Wheeler Ridge area, with a 2520 bbl per day flowing well. The discovery is producing 29.8 deg oil and 740,000 cu ft of gas from about 100 ft of oil sand between 11,452 and 560 ft.

Discovery well is on a Richfield lease owned by Kern County Land Company. There is 8500 acres in this lease and the company holds 58 leases covering an additional 3700 acres in the area.

Well is now producing at the rate of 667 bbl of oil and 140,000 cu ft of gas per day on choke.

Bandini, Hamilton Dome Acquire San Emidio Nose Acreage

Bandini Petroleum Company and Hamilton Dome Oil Company, Ltd., a subsidiary of Westates Petroleum Company, both of Los Angeles, have jointly acquired leases covering 1000 acres in the San Emidio Nose area in Kern County.

Forty-five percent of the acreage is within 1½ to 2½ miles of the recently-announced discovery well of Richfield. The balance of the acreage is scattered throughout the general area.

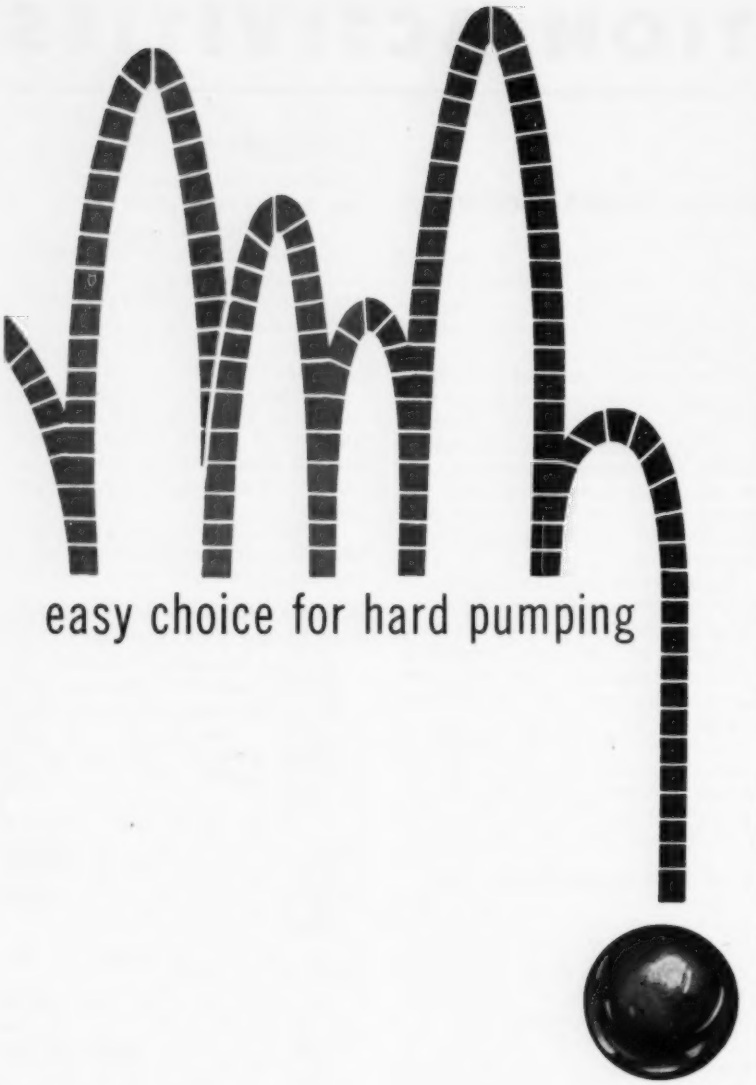
Union, Paramount Spud Wildcat on Studio Lot

A wildcat well in the heart of the Paramount movie studio near the corner of Santa Monica Boulevard and Western Avenue in Hollywood, is underway by Union Oil Company of California and Paramount Pictures Corporation. This will be a joint venture by the two companies. The test well will be drilled vertically to a projected depth of approximately 4500 ft, using electrical equipment operating within a soundproofed rig.

PARAGUAY

First Exploration in Nine Years

Pure Oil Company of Paraguay, Inc., operator for a group of five companies, has started operations at the first oil exploration test in the country in nine years. The wildcat is in the northern part of the country in a 23,200 sq mile concession. Associated in the venture with Pure are subsidiaries of Gulf Oil, Tidewater, Sinclair, and Williams Brothers Corporation. Another American company drilled five unsuccessful tests in other parts of Paraguay in the late 1940's.



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FORT WORTH

Exploration

BARBADOS

Kermac Earns Interest By Drilling 15,000 Ft Test

Barbados Gulf Oil Company, a Gulf Oil subsidiary, and Kerr-McGee Oil Industries, Inc., have been given Barbados Government approval to an agreement entered into by the two companies. Kerr-McGee Oil Industries, Inc., will earn a partial undivided interest in the Prospecting License over the island of Barbados, held by Barbados Gulf Oil Company, after reaching a certain stage of a joint project.

In accordance with the terms of the agreement, the joint project is involved in drilling Gulf Morgan Lewis No. 1. It is planned to drill this well, if possible, to a depth of 15,000 ft. The drilling of Gulf Morgan Lewis began March 17, 1958, and is located in the Scotland district near Belleplaine on the Morgan Lewis Plantation. On July 1 the well was drilling at 8594 ft.

LOUISIANA

Sun Finds Deep Sand

Sun Oil Company, as operator on a jointly and equally owned lease with Pure Oil Company, has completed State Lease No. 2620, Well No. 5, Lake Pelto area, Terrebonne Parish, as a dual oil completion.

The lower well No. 5 was completed in a new sand for the lease for an initial potential of 446 bbl per day of 32.6 deg pipeline oil on a ⅛-in. choke with a tubing pressure of 3800 psi and a gas-oil ratio of 1200 to 1 from perforations at 15,036 to 15,048 ft.

The upper well No. 5-D was completed for an initial potential of 211 bbl per day of 33.6 deg pipeline oil on a ⅛-in. choke with tubing pressure of 1825 psi and a gas-oil ratio of 733 to 1 from perforations at 13,247 to 13,256 ft.

New Gas Between Section 28, Bayou Boullion Fields

A gas discovery well in St. Martin Parish, has been finaled by Kerr-McGee Oil Industries, Inc., and The Frankfort Oil Company.

The discovery, the No. 1 LaRose, in C NW SE, of 19-19s-8e, is 10 miles northeast of St. Martinsville.

Spudded February 24, the well reached its total depth of 13,045 ft on June 7. After the well was logged, several zones in the lower portion of the hole appeared potentially productive, and 5-in. liner was run to bottom.

Four drillstem tests were run; the last was successful from a perforated interval of 12,555-75 and 12,582-88 ft. On a one-hour test, the well flowed at the rate of 5,466,000 cu ft of gas per day through an 18/64-in. choke, with flowing tubing pressure of 2900 psi.

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Exploration

PERU

Fourth Attempt in Progress

Texas Petroleum Company is drilling ahead at its fourth wildcat in Eastern Peru. The first three were drilled without success. The newest attempt is about four miles north of Yurimaguas on the Huallaga River and 110 miles northwest of the oil field near Contamana. Texas other wildcats in this region were located on the Upper Maranon River near Barranca, and on the middle Maranon near the confluence with the Huallaga River, and also on the lower Maranon near the mouth of the Tigre River.

BRITISH COLUMBIA

Richfield To Drill in Queen Charlotte Islands

A farmout agreement by Canadian Homestead Oils Ltd. and Consolidated Mic Mac Oils Ltd. has been arranged with Richfield Oil Corporation involving 861,937 acres in Canada's newest land play in the Queen Charlotte Islands area.

The deal gives Richfield the right to earn a 50 percent interest in the lands up to June 1960, in return for performing certain exploratory efforts including up to 11,000 ft of drilling. After that date Homestead and Mic Mac will have a number of options that will permit them, by surrendering a further interest, to be carried through any additional exploration that may be undertaken. They will also have the option to participate in an additional 1,000,000 acres of offshore permits held by Richfield.

LIBYA

Oasis Scores in First Try

A 720 bbl per day oil well has been in The Oasis Oil Company of Libya's first exploratory well in that North African country.

A drillstem test recovered 75 bbl of 30 deg sweet oil in 2½ hours through a ¼ in. bottomhole choke. The interval tested was a 32-ft section between depths of 5822 and 5854 ft.

Oasis Oil, a subsidiary of the Ohio Oil Company, is operator of 62 million acres of concessions in Libya held in undivided one-third interests by Ohio Oil, Amerada Petroleum Corporation and Continental Oil Company.

The discovery well, the No. 1 Bahi, is in north central Libya, 75 miles south of the Gulf of Sirte. It is located on a block of 1,250,000 acres designated as Concession 32.

NEBRASKA

Extender Renews Interest In Sernquist Field Area

Increased activity in western Nebraska's Sernquist field area has been stimulated by the completion of the No. 1 Johnson, a southwest extension well brought in by Bruce Petroleum Company and Tejas Oil & Gas Company of Houston.

Located 2310 ft southwest of previous production, the No. 1 Johnson was completed at 456 bbl per day of 40 deg oil, after several days' testing. Perforations were at 5752.5-5755.5 ft, the top 3 ft of the J Sand. The Johnson is the third producer in the field. Sernquist field is in the Denver-Julesburg Basin, in Kimball County on Nebraska's western border, on a line due east from Cheyenne, Wyoming. Magnolia Petroleum Company operates the two other producers in the field.

WEST VIRGINIA

Confirmation Attempts Underway For Nicholas County Discovery

Alaska Oil and Mineral Company, whose primary holdings are in the new state, have announced the successful completion of its first mainland exploratory gas well on an 8000-acre leased site in Nicholas County, West Virginia.

The yield of the well is expected to be 1,600,000 cu ft per day. Two offsets to the well are to be started immediately and a second well, on the same tract, is nearing completion.

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The accuracy of McCullough Well Logging Services assured the successful reduction of gas/oil ratio in this Canadian oil well.

Depth of operation was approximately 3200'. Seven inch OD 20 lb. casing had been set on top of the pay. Production was from 6⅛" open hole with a gas/oil ratio of 1800 cubic feet per barrel.

McCullough's Radiation Well Logger with Scintillation Detector was run to determine the depth and detail of the oil sand. Simultaneous Gamma Ray and Neutron Curves were recorded. Gas/oil contact was established from the Neutron Curve. Following this a McCullough Caliper Log obtained excellent detail of the open hole.

From this information a production packer was set and the well was put back on production. Gas/oil ratio decreased from 1800 to 200 cubic feet per barrel.

Accuracy plus reliability of down-hole information are prime requisites to the successful completion of jobs like this. And you can be sure of these qualities when you call for McCullough Well Logging Services.

The job described above is certified to be a true field report of service rendered.

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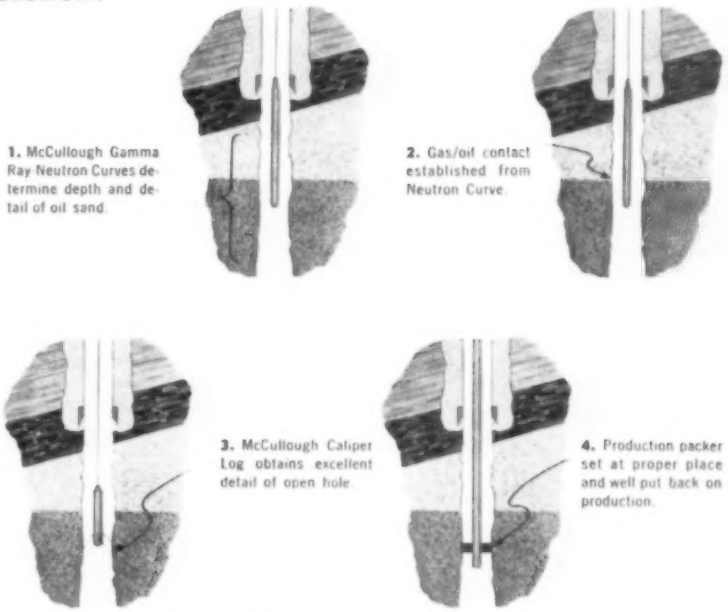
PROBLEM: Gas/oil ratio too high – 1800 cubic feet of gas per barrel of oil.

SOLUTION:



1. McCullough Gamma Ray Neutron Curves determine depth and detail of oil sand.

2. Gas/oil contact established from Neutron Curve.

3. McCullough Caliper Log obtains excellent detail of open hole.

4. Production packer set at proper place and well put back on production.

RESULT: Gas/oil ratio reduced from 1800 to 200 cubic feet of gas per barrel of oil.

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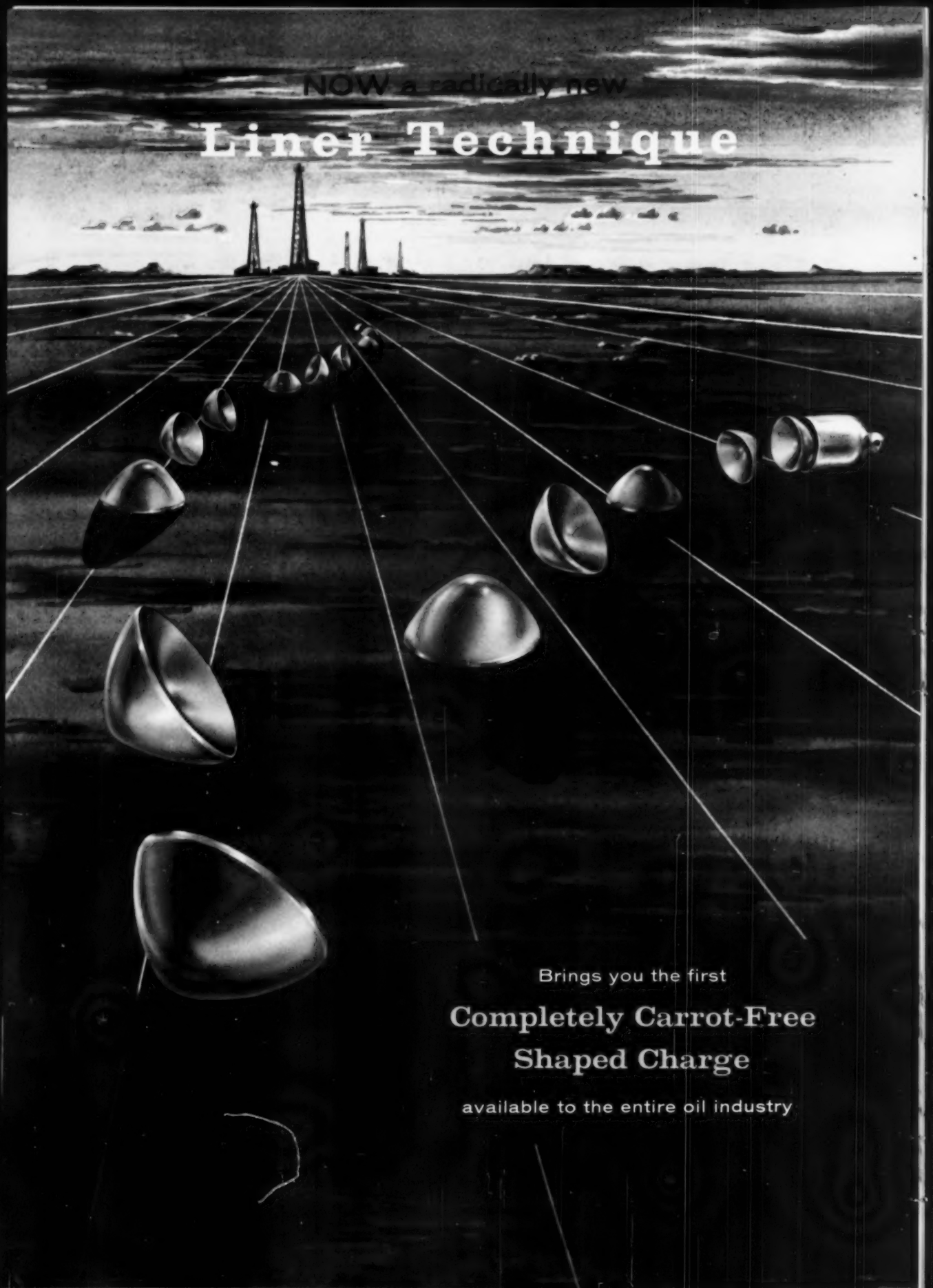
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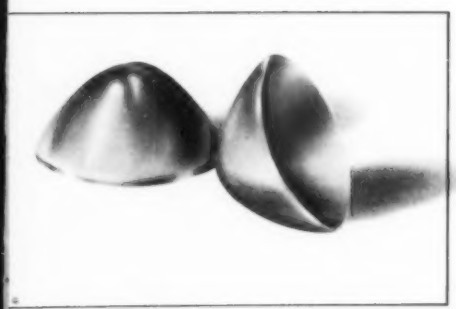

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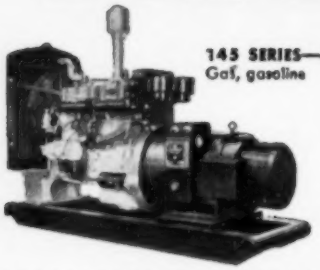

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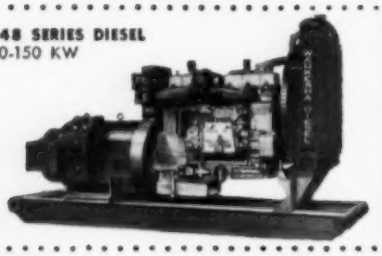

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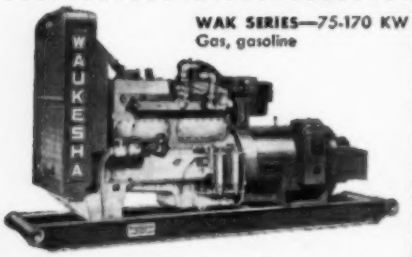
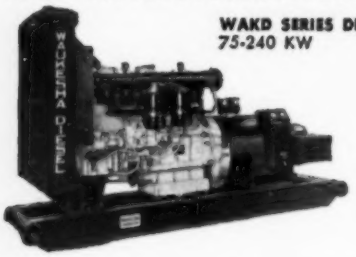


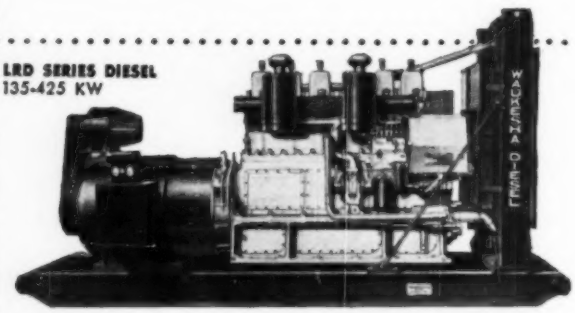
WAK SERIES—75-170 KW
Gas, gasoline

- Developed by more than fifty years experience in building heavy-duty engines and electrical equipment, Waukesha Enginators are accurately balanced engine and generator combinations that perform dependably in all applications requiring a smooth, steady flow of power for continuous, intermittent and standby duty.

50 to 800 KW capacities—gas, gasoline, normal or turbocharged Diesel operation.



WAKD SERIES DIESEL
75-240 KW



LRD SERIES DIESEL
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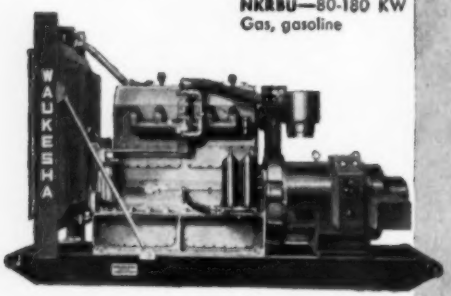
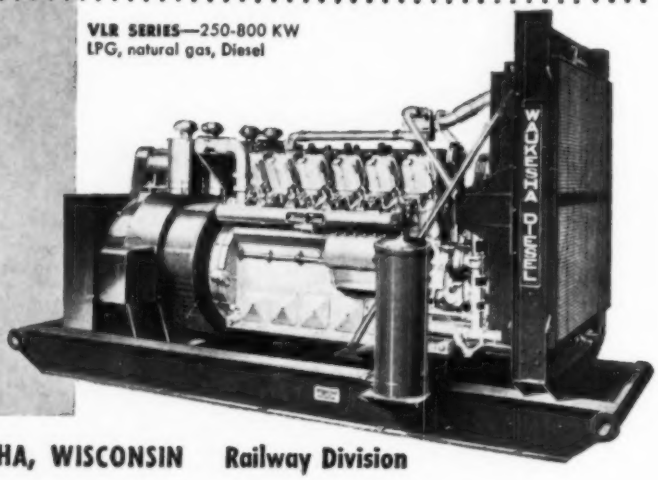


NKRBU—80-180 KW
Gas, gasoline



VLR SERIES—250-800 KW
LPG, natural gas, Diesel

WRITE for bulletins for these and other models

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WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN Railway Division

What do operators expect of drilling contractors?

MORE THAN 'A HOLE IN THE GROUND'

What do drilling contractors expect of operators?

MORE THAN 'MORE MONEY'

J. E. Harrington
General Petroleum Corporation
Santa Fe Springs, California

IT IS THE OBLIGATION of both drilling contractors and operators to help improve operations through experienced personnel and modern facilities that we have gained over a period of years.

Also, any sound businessman — whether contractor or operator — must continually strive for improvements in more modern equipment, methods, planning and safety programs in order to meet our challenge in the oil industry.

We are in business to make money. It may be noted that a great amount of money can be made and saved by having a first class, modern accident prevention program. This is something every drilling contractor and operator must have in common.

Although many facets of the contractor-operator relationship may not be held in common, certain things are expected of the other. A knowledge of these expectations is necessary for continuing pleasant business relationships and any improvement of workmanship.

Seven or eight drilling contractors were contacted to find out what they expected of the operator or oil company. General Petroleum Corporation has done business with them for quite a number of years; they are very reputable people in the oil industry and are an asset to the communities in which they live.

What the Contractor Expects

Here are several requisites that these contractors expect of operators:

1. **To be treated the same in their operations as company crews and personnel are treated.**

Their explanation is about like this: After all, they are all human, and the contractor is trying to perform a service to a company.

2. **They expect the company to carry their responsibility as per the contract agreement.**

This means that a company should not expect a contractor to take all the responsibility of drilling an oil well unless so stated in the contract.

3. **They expect a company to follow the drilling programs that have been submitted insofar as possible as per original drilling contract, because the contractor's bid is based on the original drilling program.**
4. **They expect a company not to have mud disposal or purchase of mud responsibility on the contractor, if it is known there is a possibility of excessive mud problems. (For example, lost circulation zones, heaving shale, complete mud changes before total depth, etc.)**
5. **They expect a company not to use the present idle rig situation as it is today to beat down the price per foot or cost per hour.**

Bids are based today on very small profit, if any, and the contractors are having a difficult time trying to keep their organizations together and show a profit.

6. **They expect a company to make payment of invoice when due.**

Contractors today are working on such small margins that it is imperative they receive payments on time in order to meet their current payrolls, earn trade discounts and keep their many suppliers happy.

7. **They would like companies to recognize the American Association of Oilwell Drilling Contractors as a bona fide and honorable organization.**

The contractors who belong to this organization are spending lots of time and money to improve oil well drilling operations through research programs, mud schools, public relations, safety programs, rotary drilling committees and allied activities.

Moral Liabilities

One contractor expressed his desires and expectations in about this language:

1. They expect a firm and concise program for the contractor to submit his bid, based on general conditions in the area where the well is to be drilled.

The company should furnish as much geophysical or geological information as possible, if this is a wildcat well. Also, under this category, they would rather a company would not change a program too drastically from the program that the bid was originally contracted for.

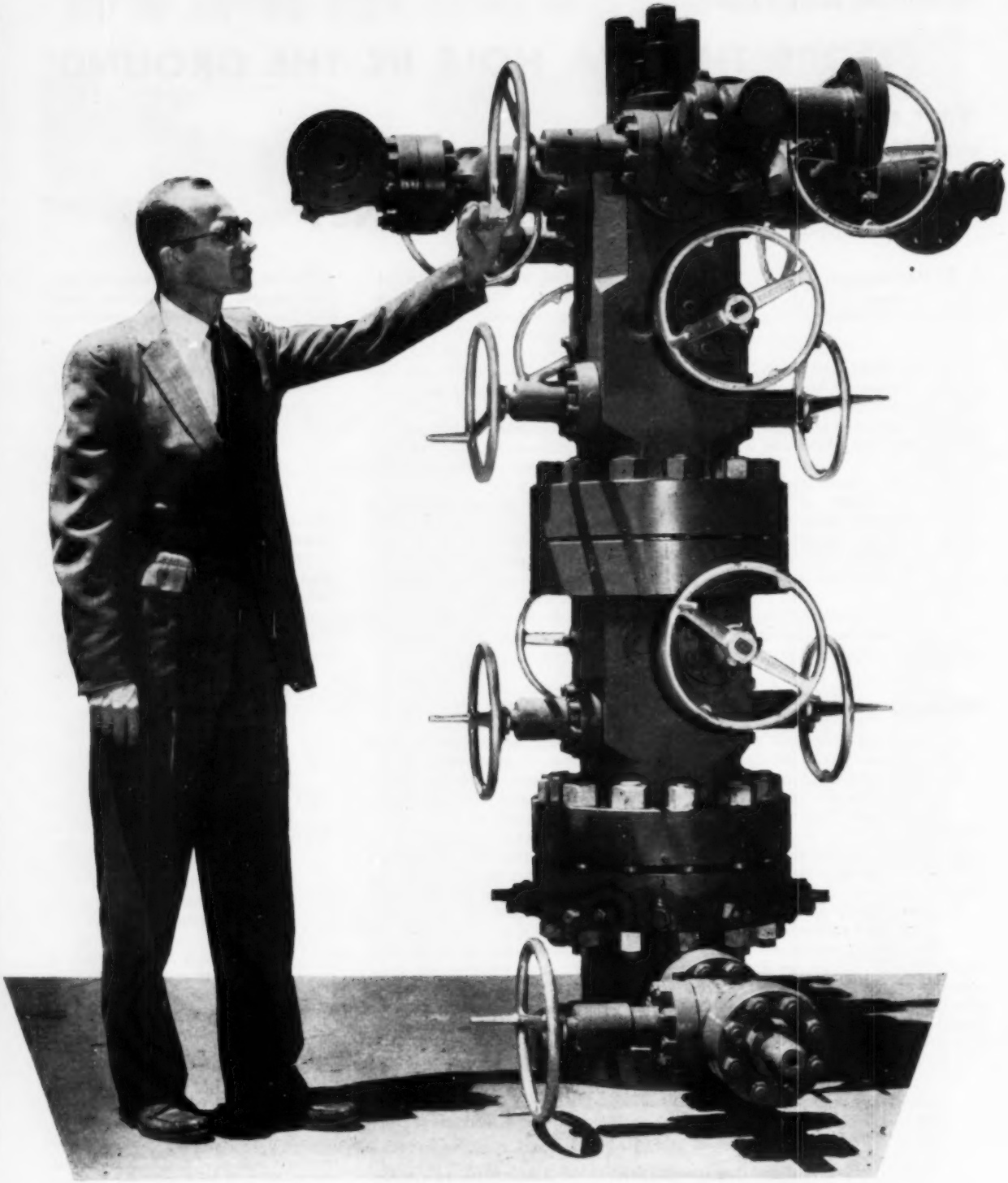
2. Award contract to most realistic bidder with consideration of the equipment available for the job and the best trained personnel.
3. Treat contractor as any other employee working with them during operations.
4. Both contractor and operator have a moral liability as well as a legal liability to each other, and operator should respect this.
   (a) Company should not hold contractor responsible for conditions beyond his control.
   (b) Company should not expect more than the contract calls for.
   (c) Company should pay bills as prompt as possible.

Proper Contractor Appraisal

Another contractor's first comment as to what he expected of an operator was: "More money." However, he stated that the operator did not have as much control of that as the contractor, so he said he would not list that item. Following are his comments regarding what he expects from an operator:

1. Clear and precise specifications with adequate check list.
2. Proper appraisal of contractor's

Presented at the American Petroleum Institute's midyear meeting of the Safety and Fire Protection Committee in Denver, Colorado, May 5, 1958.

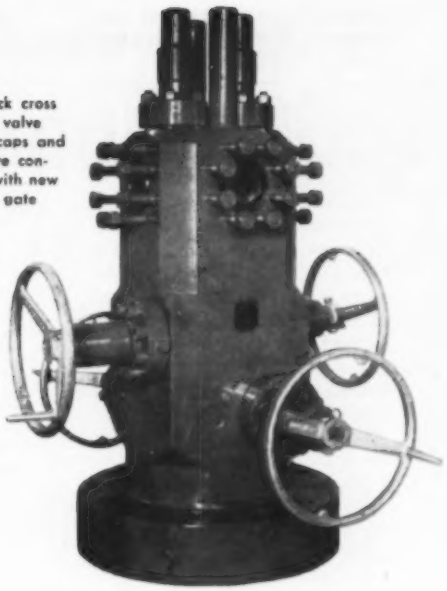


4 PARALLEL PRODUCTION STRINGS

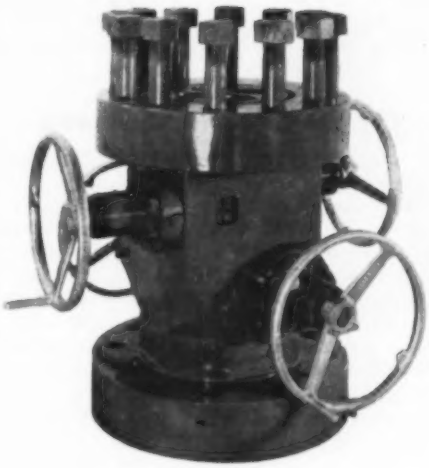
The fortunate circumstance of 4 producing sands in one well means more today than ever before. The reason is Cameron's new quadruple completion equipment – the first of its kind. This equipment, which is already in service,* includes all of the time tested features of the highly successful Cameron dual and triple hangers and seals plus a new unitized tree design. Strings may be run or pulled independently. The segmented hangers provide maximum clearance for running special tools. Each hanger segment will support full joint strength loads. With all hanger segments in place, annulus seals may be activated by plastic packing injection to withstand annulus pressures equal to the full working pressure of the tubing head. There are triple seals for safety and positive orientation of hangers. Cameron's reliable back pressure valves afford complete control of well pressure through every phase of setting.

The new quadruple string solid block master valve and the solid block cross type valve are made possible by the Cameron gate valve with its rotating seats and remarkable durability. Choke valves and caps attach directly to the compact solid block body of the cross type valve to complete this newest addition to multiple production and multiple profits. With this design only the size of the casing limits the number of parallel strings that may be hung.

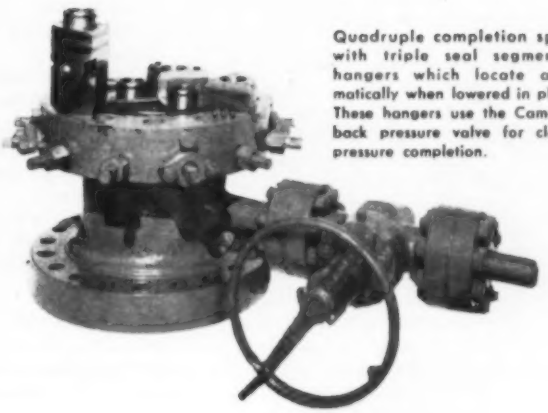
* *Oil industry's first 4 parallel string quadruple zone completion by CATC Offshore Group. Completion date June 19, 1958.*



Solid block cross type tree valve showing caps and wing valve connections with new Cameron gate valves.



Solid block quadruple string master valve with new Cameron gate valves.



Quadruple completion spool with triple seal segmented hangers which locate automatically when lowered in place. These hangers use the Cameron back pressure valve for closed pressure completion.

Cameron

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equipment and personnel and proper consideration for his past good service.

3. Operator should coordinate thinking with both field and office regarding contract terms.
4. Multiple whole bids, when possible, to enable the contractor to improve his performance in a given area.
5. Operator should not ask footage bids in high-risk or unknown areas. Day work or other types of bids might be used, such as an incentive type, low day rate plus footage bonus. Or the escalator clause type might be appropriate. (The escalator type is where an operator and contractor agree on the number of days a job should take, with a refund by contractor if the job is accomplished in less time than agreed, or operator to pay the same amount per day for time over that agreed upon.)
6. Operator should give all available information to contractor so that he may make a realistic and intelligent bid.
7. Operator should allow compensation for extra supervisory personnel when needed.
8. Contractor should receive a handling fee for third-party services.
9. Operator should keep responsibility within reasonable limits.
10. Contractor should receive extra compensation for items in excess of those normally supplied, such as large numbers of drill collars.
11. Contractor should have mud control while on footage portion of contract whether mud is supplied by operator or contractor.

Third Party Handling

Another contractor bases his opinion on the following:

1. Operator should assume full responsibility for the hole when drilling is being done on day work basis.
2. On footage rate contracts where coring is done on day work rates, the hole should be left at the same deviation upon completion of coring as it was when coring commenced.
3. Casing and tubing tools should be furnished by operator.
4. Cash discounts should acerue to the benefit of contractor on all third-party buyouts and contractor should be allowed a 5 percent surcharge to cover overhead in handling.
5. A 12 hour lost circulation clause should be included in all contracts.
6. If drill pipe is stuck due to lost circulation, operator should take over at that point, as contractor and operator seldom see eye to eye on fishing jobs.
7. Percentage of funds withheld by operator after completion of well on day work rates should not exceed 10 percent.
8. Excessive mud pump pressure should not be required by operator but should be maintained at a level in line with the capacity of present day oil well drilling equipment. Prices do not permit the purchase of the type of equipment asked for.

What the Operator Expects

This is a fairly complete picture of what several contractors expect of operators. What does the operator expect of the contractor?

When the operator submits a program to various contractors for bidding, first consideration is the honesty and reliability of the people with whom we expect to do business, the machinery and equipment they have available for the particular job, and the personnel they have available, especially supervisory personnel.

Public Relations

I know in our organization we quite often insist on certain toolpushers to supervise rig operations while drilling wells for us.

After the contract is let, it seems to me that the contractor and company must have a good understanding of what they expect of each other. It is evident that they should have good relations. Because contractors may be drilling a well in a new location, they, as I have mentioned before, will be our public relations people in that area. Inasmuch as we are a marketing concern as well as producers, I believe we should expect the contract personnel to be considered as our front line people in that community, and certainly they can build a good reputation for our company or a poor one. It is very important this day and age that we have good relations with those we expect to do business with and those we are doing business with.

It is realized that a contractor has some problems which the operator does not have: An important one being their labor turnover, which hinders them somewhat in training and developing people who will stay with them any length of time. Therefore, it may be difficult for the contractor to have the proper communications and relations with the communities that we might desire.

The average operator expects the following from the contractor:

1. **A good reputation.**
2. **Good drilling equipment.**
3. **Trained personnel to do a good day's work.**
4. **A thorough understanding of company policies.**
5. **Legible and complete reports.**
6. **Accurate measurements.**
7. **A good safety and fire prevention program.**
8. **Follow orders as instructed.**
9. **Keep equipment in good repair.**
10. **Be a good public relations representative.**

In the past several years, I believe the operators and contractors have come to know each other better; and, realizing they have the same problems, there has been very little misunderstanding between them.

Because all operations are moving so rapidly and conditions are changing so fast, I think our nation is beset with difficulties and confusions. Many of us have doubt and grave concern for the future. But no one who reviews the past and realizes the vast strength of our people can doubt that this, like a score of similar experiences in our history, is a passing trial. From this knowledge must come the courage and wisdom to improve and strengthen us for the future.

Meeting of the Minds

We must not be mislead by the claim that the source of all wisdom rests in one concern. Wisdom is born out of experience and most of all out of precisely such experience as is brought to us by some of the roughest problems. It is in the meeting of such moments that are born new insights, new sympathies, new powers and new skills which are brought out by gatherings like we are having here today.

If there are any conflicts in our midst, I believe by the meeting of the minds, by keeping faith within ourselves, by the use of our resourcefulness and the initiative of every one of us, we cannot fail. If we keep faith in our future, in the constant growth of our intelligence and our ability to cooperate with one another, then there should be no misunderstanding ever between the operator and the contractor. ★ ★ ★

THE OASIS—

A gathering spot for NOMADS

New York Golf Party Brings 148

The New York Chapter of Nomads annual June Golf Party netted 110 golfers and grossed 148 guests for dinner at the White Beeches Golf and Country Club, Haworth, New Jersey. Shown below are many of the prize winners. Not shown are Mario Cueto, high gross guest, Reed Roller Bit; J. Moore, low gross runner-up, Chain Belt Company, and R. LeBus Jr., high gross Nomad, Baash-Ross.

Championship group rising from the 110 golfers were Bert Youmans low gross guest, Connecticut Spring; John Madden, low net Nomad (shown with I. Frank Brown trophy), National Supply, and E. F. Gahan, low gross Nomad. E. F. Gahan, Inc.

Runners-up include J. E. George, low gross runner-up Nomad, Mid-Continent Supply; J. W. Kerr, low net guest, Aramco; W. F. Menicke, low net guest runner-up, Aramco; A. V. Simonson, low net Nomad runner-up, A. V. Simonson & Co.

Longest and nearest are H. E. Lowrey, longest drive Nomad, Continental-Emsco; F. G. Shemmer, nearest to pin Nomad, Pacific Valves; C. R. Eble, longest drive guest, Midwest Piping.

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What's doing in DRILLING

Drilling Activity Continues Upward

In the last week of April, drillers were wondering if the downward spiral of drilling activity started in December 1957, would ever end. For some contractors, it was no longer a matter of concern just how low the number of active rigs might go . . . their rigs were already idle. But, starting from a low of 1870 active rigs in the U. S. and Canada on April 28, the count has increased steadily to 2002 active rigs on July 7.

Western Canada, however, is again experiencing a decrease in rig activity. From a total of 164 active rigs on June 16, the count has dropped to 134 on July 7. This decrease is possibly a reflection of the difficulty that Canadian natural gas producers are having in finding markets for their gas. Meanwhile, Eastern Canada continues to report 3 active rigs throughout the report period.

Glasscock-Wilson, Inc. Becomes Fred Wilson Drilling Company

Fred Wilson, one of the two owners of Glasscock-Wilson, Inc., Shreveport based drilling company, purchased for $1,280,000 all of the interest of the other owner, Charles W. Glasscock in a sale concluded June 30. According to a joint announcement by Glasscock and Wilson, the operation of the company will continue without change or interruption. All personnel and equipment will be retained and the same policies will be continued as in the past.

Wilson said that in assuming full ownership of the drilling company, he has changed the name to Fred Wilson Drilling Company. The company will continue to operate its six drilling rigs in the Louisiana Gulf Coast area.

Humble Rig Sets Company Safety Record

One of Humble Oil & Refining Company's Eastern Division rigs has set the company's very impressive safety record. When the 1957 safety records were closed out at the end of February, the men of Rig 39 could lay claim to a record total of 472,449 man-hours of work without a lost-time accident.

In racking up this accomplishment, the drillers operated their heavy duty rig in 13 different fields, completing a total of 38 wells at an average depth of 12,391 ft. Some of the wells were drilled on land, some from a platform offshore in the Gulf of Mexico, and some from a barge in the marshlands of Louisiana. The long accident-free operation also won for the crews of Rig 39 five consecutive annual awards as the company's safest drilling team.

Much of the credit for the record goes to Humble's safety training program. But, says Ralph J. Schilthuis, vice president in charge of production, "All the safety training in the world won't prevent accidents unless the men themselves remember to use their safety knowledge. The crew members of Rig 39 are giving an outstanding demonstration of the fact that with proper training and mental alertness, accidents can be prevented."

Drilexco Broadens Operations in East

Drilling & Exploration Company, Inc. has announced the completion of negotiations with Iraq Petroleum Company, Limited, whereby Drilexco will ship two new rigs to Iraq to commence drilling operations soon for I. P. C. The first rig will be shipped about August 1, and the second on approximately September 1.

The operation is handled through Drilexco's recently organized wholly-owned subsidiary, Drilling & Exploration, Ltd., and further extends the company's international scope of drilling activities. Drilexco, through its subsidiary companies, is also active in the Eastern Hemisphere with operations in Turkey, Arabia, Holland, Italy, and Nigeria.

"Mighty Mole" Completes First Assignment

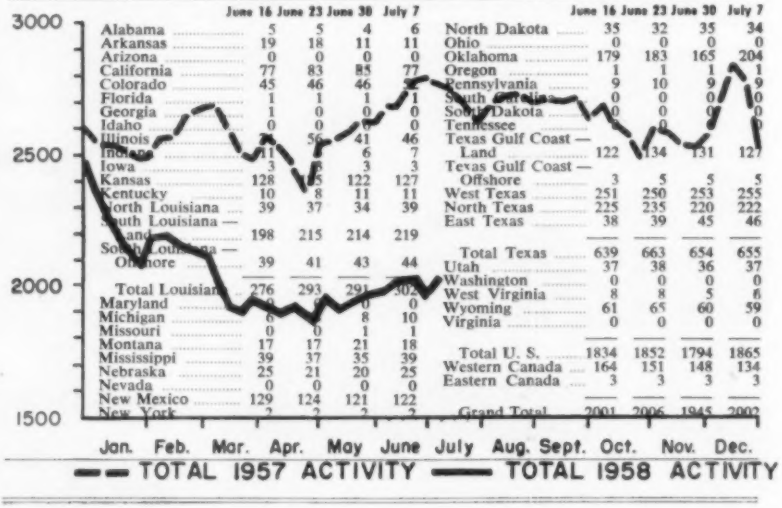
Within two weeks of its introduction to the oil industry at Bakersfield, California, the Brown Drilling Company's new lightweight portable drilling rig, "Mighty Mole," completed its maiden well at a 5320-ft depth on Robert's Island, near Stockton, California. Arthur J. Heiser, Brown vice president, said the rig performed "beyond expectations" on the break-in job, producing a total of 1500 usable horsepower. Power checks during the job, which was for Standard Oil of California, showed 478 hp going to the pump on the new equipment. The portable rig uses turbo-supercharged diesels all through the installation.

Toolpusher and superintendent on the "Mole's" first job is W. W. (Boots) Lipscomb and Al Albiston of the Brown company is drilling superintendent. The Robert's Island job is located in the Sacramento River island country, about nine miles west of Stockton. One more hole remains to be drilled on the Standard contract there before the "Mole" moves on to its next assignment.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.

	June 16	June 23	June 30	July 7
Alabama	5	5	4	6
Arkansas	19	18	11	11
Arizona	0	0	0	0
California	77	83	85	77
Colorado	45	46	46	51
Florida	1	1	1	1
Georgia	1	0	0	0
Idaho	0	0	0	0
Illinois	56	56	41	46
Indiana	11	8	6	7
Iowa	3	3	3	3
Kansas	128	125	122	127
Kentucky	10	8	11	11
North Louisiana	39	37	34	39
South Louisiana — Land	198	215	214	219
South Louisiana — Offshore	39	41	43	44
Total Louisiana	276	293	291	302
Maryland	0	0	0	0
Michigan	6	8	8	10
Missouri	0	0	1	1
Montana	17	17	21	18
Mississippi	39	37	35	39
Nebraska	25	21	20	25
Nevada	0	0	0	0
New Mexico	129	124	121	122
New York	2	2	2	2
North Dakota	35	32	35	34
Ohio	0	0	0	0
Oklahoma	179	183	165	204
Oregon	1	1	1	1
Pennsylvania	9	10	9	9
South Carolina	0	0	0	0
South Dakota	0	0	0	0
Tennessee	0	0	0	0
Texas Gulf Coast — Land	122	134	131	127
Texas Gulf Coast — Offshore	3	5	5	5
West Texas	251	250	253	255
North Texas	225	235	220	222
East Texas	38	39	45	46
Total Texas	639	663	654	655
Utah	37	38	36	37
Washington	0	0	0	0
West Virginia	8	8	5	6
Wyoming	61	65	60	59
Virginia	0	0	0	0
Total U. S.	1834	1852	1794	1865
Western Canada	164	151	148	134
Eastern Canada	3	3	3	3
Grand Total	2001	2006	1945	2002



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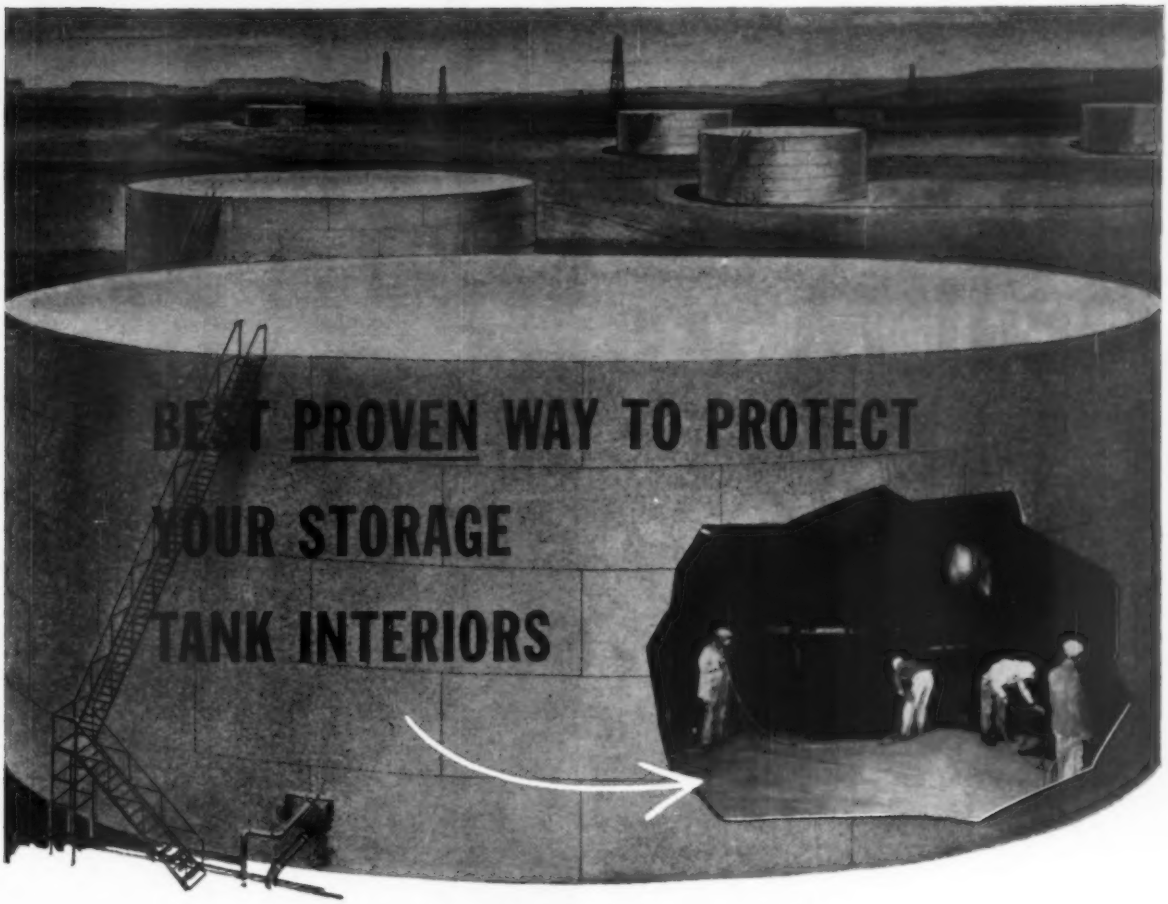

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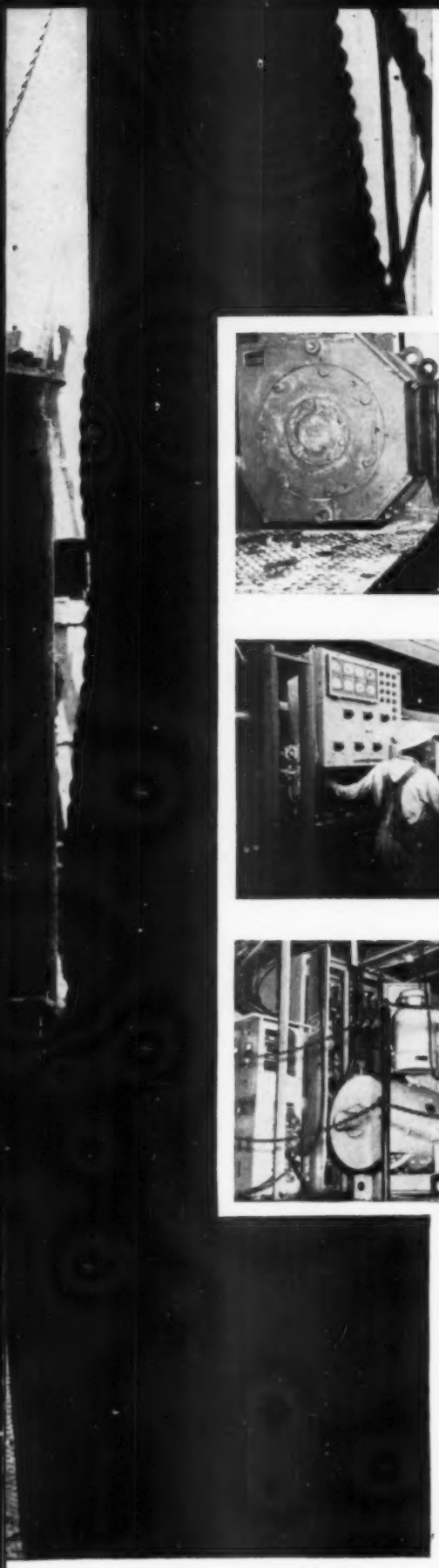

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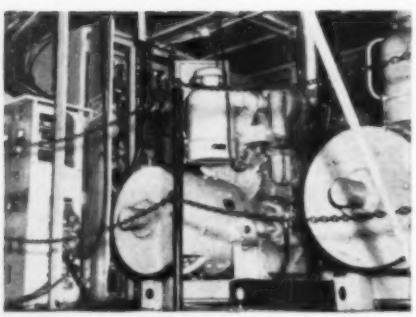
G-E Drive control is simple to operate and easy to understand. The driller's console may be floor-mounted or drawworks-mounted, to suit your requirements. Familiar, proven, air-operated devices give you positive control over all drilling functions, which enables you to drill more hole. And with G-E Drive, the main control compartment may be located away from the drilling area. It requires no attention during normal drilling operations.



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SAND PUMP SIZES IN STOCK

O.D.—2½, 3, 3½, 4¼, 5, 5½, 7 in. Lengths, 20, 25, 30 ft.

Composite Catalog Page 3419

MILLER SAND PUMPS

Miller Sand Pump Co.
General Offices, Box 4516
Oklahoma City 9, Okla.

EXPORT OFFICES
30 Rockefeller Plaza
NEW YORK 20, N. Y.

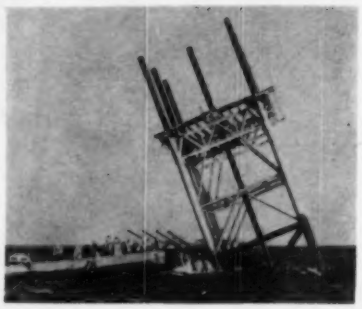
Parker Drilling Begins Operations in Brazil

The formation of a new company, the Parker Drilling Company of Brazil, has been announced by Robert L. Parker, president of Parker Drilling Company of Tulsa. The new subsidiary is taking over the immediate operation of some drilling rigs in Brazil for the Brazilian oil company, Petrobras.

Drillsites for the Brazilian exploratory tests will be about 1200 miles up the Amazon River with the base camp at Manaus. The Brazilian government recently appropriated several millions of dollars for oil exploration.

Offshore Platform Launching Equipment

In a joint announcement, Coastal Marine Drilling and Construction Corporation, L. B. Christenson Engineers, Inc., and Todd Shipyards Corporation unveiled a new unit known as a controlled platform launching barge expected to reduce cost of installing and recovering offshore drilling platforms. The launching barge actually consists of two barges which are hinged together. One barge measures 130 ft by 56 ft and the other 130 ft by 32 ft. The two barges carry the platform from shore to drilling site, the barges are



carefully positioned, and then the smaller barge is gradually submerged through a 90 degree arc by the combined action of ballasting and four hydraulic rams.

While being transported, the platform rests on its side on both barges, but at the time of launching, it is fastened only to the submerging barge, and like the barge it moves downward into the water from a horizontal to a vertical position. Once upright and resting on the bottom, the platform is automatically released from the barge, the barge is gradually returned to its original horizontal position on the surface, and the platform is secured to the bottom with its integral steel pilings. The present barge can place platforms weighing up to 850 tons in as much as 120 ft of water.

$17 Million Pipe Mill in Operation

A new $17,000,000 continuous weld pipe mill has been put into operation by Jones & Laughlin Steel Corporation at Aliquippa, Pennsylvania. It is the second such company plant for the production of small-diameter pipe.

The expansion program at J&L's Aliquippa Works has cost $200,000,000 in the past 10 years, and has increased steelmaking capacity at the plant turning out seamless and welded pipe, tin plate, wire products, strip mill products, and a broad range of structural shapes. Facilities added at the plant include two basic oxygen furnaces, a 44-in. hot strip mill, an electricweld line pipe mill, expanded soaking pit facilities, and additions and improvements in many other departments.

The continuous weld mill just put into operation is capable of producing welded pipe in a nominal size range from 1¼ through 4 in. The first mill, completed in 1957, has a size range of ½ through 2 in. nominal pipe size.

The mills incorporate the latest features in the production of continuous weld pipe for plumbing and heating, and oil and gas distribution lines. Other applications for the pipe include conductors for steam, water, and air, and a wide variety of industrial uses such as sprinkler systems, air conditioning, prime electrical conduit, refrigeration, and structural purposes.

In the continuous weld process, skelp or strip steel in coil form is passed through a furnace, formed in a series of rolls, and welded into pipe. Each coil is welded onto the preceding coil, thereby providing an endless strip of skelp. A loop table permits this welding without delay of production.

The continuous weld process differs from the conventional butt weld in that it entails the use of skelp in coil form rather than single strips.

The continuous weld pipe mills replace J&L's two butt weld mills, constructed in 1926. The new mills are located on the sites of the older mills in the Aliquippa Works' welded tube department.

When you want the best-
Call Otis
for Running and Pulling Otis Sub-Surface Controls Under Pressure • Squeezing Thread Dope in Tubing Under Pressure • Wire Line Fishing Jobs • Running and Pulling Tubing and Drill Pipe Under Pressure • Internal Calipering of Tubing and Casing • Drilling and Repairing Gate Valves Under Pressure • Patented Otis Dry Ice Process for Emergency Repairs • Running Otis Gas Lift Equipment • Perforating and Cutting Off Tubing Under Pressure • Otis Permanent Completion Tools and Services
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Branches Throughout the Oil Country

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

It's New

Drilling – Producing Equipment

Shorty-Tension Packer Announced

The Guiberson Corporation announced availability of their new line of shorty packers. The shorty-tension packer is an exceptionally short packer designed for use in waterflooding, acidizing, fracturing and other below-packer pressure applications. Simple, rugged construction makes redressing an easy operation and assures positive setting and quick release.

Construction features include right-hand release safety joint coupling, heavy 1-piece seamless steel mandrel, J-slot latch, malleable iron friction pads which operate independently of the slips, and drillable cast iron head. Special rubber is lab-tested to 6000 psi differential at the packer at 300 F. Predetermined tension load at the packer shears nut and releases nut, thimble, rubber, and head — all drillable. *The Guiberson Corporation, one of the Dresser Industries.*

Circle number (1) on reply card.

New Wireline Cementing Tool Introduced

A new and different wireline cementing tool has been introduced by Welex, Inc. The tool was developed for more predictable results in increasing displacement, preventing cement contamination, eliminating tool movement during the pressurizing cycle, obtaining a satisfactory packer seal under high pressure, retaining pressure for a prolonged period of time and equalizing pressures following the squeeze. A rocket fuel propellant is utilized, designed to burn at a retarded rate to create larger quantities of gas at a higher temperature.

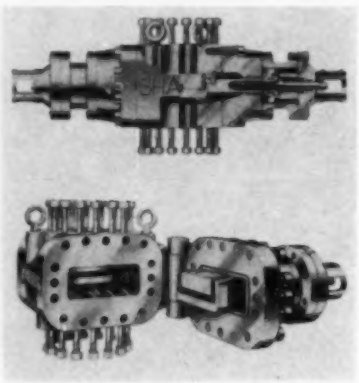
Another of the innovations built into the tool is a hydraulic hold-down anchor which holds the tool stationary while pressure is applied. The anchor holds pressures in excess of 10,000 psi differential. The release mechanism in the tool has a positive means of releasing pressure by equalizing the pressure inside the tool with that of the hydrostatic head in the borehole.

Because of the design of the tool and the measuring system used in the hoist equipment, selective placement of the cement is another advantage of the cementing tool. With a propellant that generates a predictable volume of gas, a trouble-free hold-down, a positive sealing packer, and release mechanism, the entire squeezing operation is speeded up considerably. *Welex, Inc.*

Circle number (2) on reply card.

High Pressure Blowout Preventer

Shaffer Tool Works has announced production of the industry's first large-bore blowout preventers for handling working pressures of 10,000 psi (15,000 psi test pressure). The units feature extra high pressure hydraulic gates. "In-line" ram-piston design reduces seals, parts, and maintenance to a minimum. Another



feature of the units is the hinged body design. Entire ram compartment may be swung open by unbolting the ends of the units.

The equipment is in production in 7 1/16-in., 9-in., and 11-in. bore sizes. The 7 1/16-in. bore size is tested to 22,500 psi for working pressures to 15,000 psi. The other two sizes are tested to 15,000 psi for working pressures to 10,000 psi. All sizes can be furnished for either studded flange or bolted flange connections. *Shaffer Tool Works.*

Circle number (3) on reply card.

Air-Driven Drum Agitator

A new line of air-driven drum agitators designed for use in hazardous atmospheres is available from Prenco Products Inc. The units are portable and can be used on standard 55-gal drums when agitation of explosive liquids prohibits use of electrical equipment. Standard mixing shaft and paddles of carbon steel meet most applications. For corrosive fluids, stainless steel shaft and paddles are available. *Prenco Products Inc.*

Circle number (4) on reply card.

Tubing Bleed-Off Assembly

Brown Oil Tools has announced the Brown tubing bleed-off assembly for pulling sanded-up or plugged tubing. Pulling operations sometimes are unsafe because pressure is trapped between bridges in the tubing. The tubing bleed-off assembly minimizes the danger by controlling the well, pressure and fluid in the tubing at all times.

The equipment basically is a pressure-tight mud-box with seals that hold in both directions. Outlets are provided between the seals to allow for controlled bleeding-off of trapped pressure, and to allow for circulation back into the hole to kill the well. Two side outlets provide a means of connecting a pressure gage, and, if desired, a flow line, between the seals. It is designed for either 2-in. or 2½-in. nominal tubing. *Brown Oil Tools, Inc.*

Circle number (5) on reply card.

Portable Perforating Unit

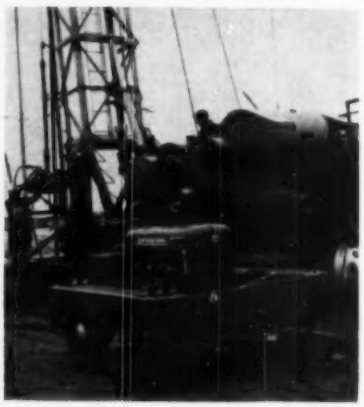
A new perforating attachment has been announced by Well Reconnaissance Inc. The perforator is designed to be used with the company's Geo-Logger, a portable logging unit equipped to take electric and radioactivity logs, temperature logs, and caliper logs. The perforating attachment utilizes expendable type charges. *Well Reconnaissance, Inc.*

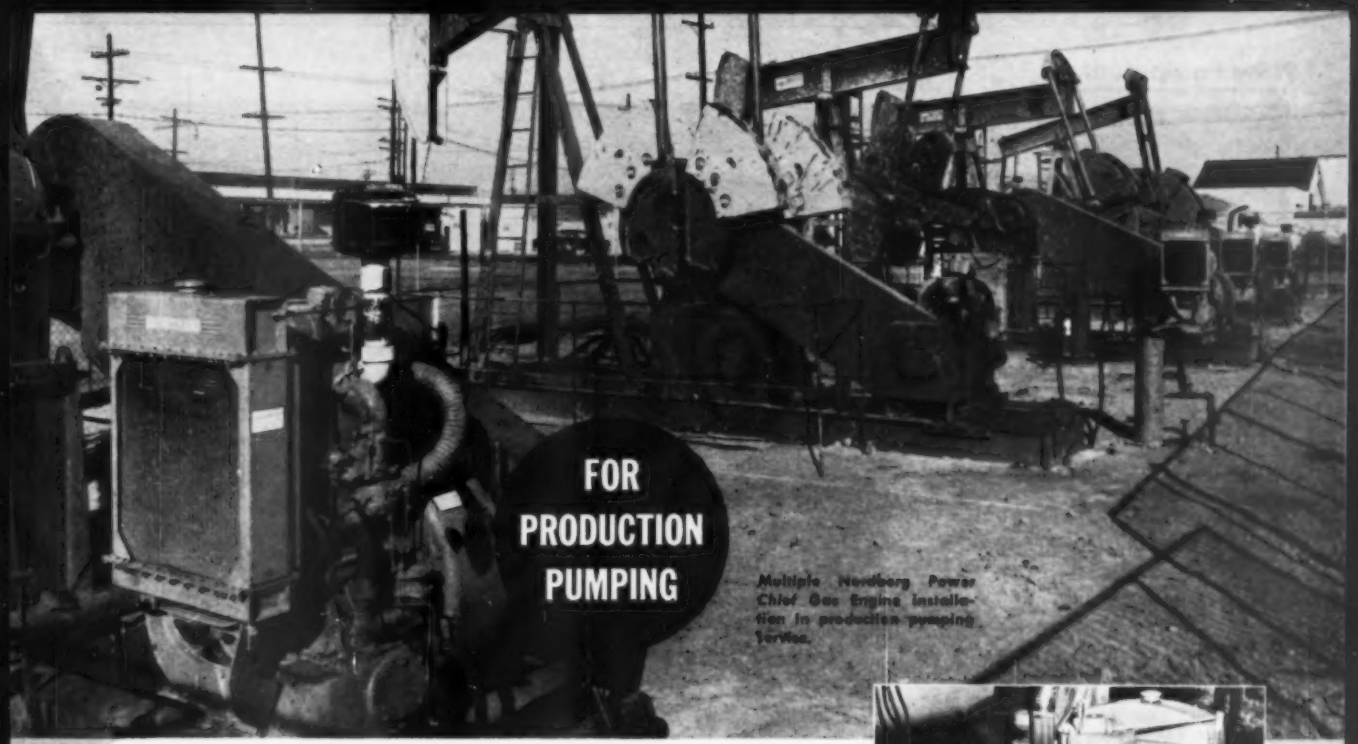
Circle number (6) on reply card.

Oil Well Pump Servicing Unit

A compact, trailer-mounted hydraulic system has been devised by Harris Sisson Rental Tongs, Inc., to speed work in repairing oil well pumps. Engine and hydraulic pump are mounted on a 4-wheel trailer which can be towed behind a car or pick-up truck from job to job. The hydraulic system powers tongs used to pull the tubing and pump out of the well. The hydraulic pump is powered by a carbureted engine. The firm has 2 of these mobile units in the Odessa, Texas. area and plans to add 2 more to its fleet. *Harris Sisson Rental Tongs, Inc.*

Circle number (7) on reply card.





Multiple Nordberg Power Chief Gas Engine installation in production pumping service.

NORDBERG POWER CHIEF® ENGINES

are your BEST BUY!

In the low cost medium speed field, *Power Chief* engines give you all the design, construction and fine quality that has made Nordberg engines famous throughout the world for over 50 years. *Power Chief* engines are so simple in design that they can be maintained, in the field, with only a few ordinary hand tools.

Here are some of the features that make *Power Chief* engines your *Best Buy:*

Removable wet cylinder liners • Valves in head • Replaceable valve guides • Special alloy inserted exhaust seats • Positive full pressure lubrication • Internal ventilation bars entry of dirt • Crankcase and all other vital parts fully sealed • Oil heat exchangers maintain proper internal temperatures at all loads • Safety approved, enclosed heavy flywheel smooths out fluctuating loads • Fram oil filters • Vortox oil bath air cleaners • Wico & Bosch magnetos • Twin Disc clutches • Murphy safety shut-down devices. (No extra added costs for these when you buy.)

Power Chief Gas Engines in 1 and 2-cylinder models deliver up to 36 hp maximum rating. *Power Chief* Diesel Generator Sets produce 6 to 30 kw for continuous service. All are available with special vibration-proof mounting. NORDBERG MFG. CO., Milwaukee, Wisconsin

Typical rig-mounted *Power Chief* Diesel Generator Set for lighting service.

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Write for Bulletin describing Nordberg *Power Chief* Oil Field Engines.

AVAILABLE AT YOUR LOCAL SUPPLY STORE — OR CONTACT THESE AUTHORIZED DISTRIBUTORS:

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BRANCHES: Houston, Odessa, Olney
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IN-MAR CO., Wilmington, California

STEPHENS OIL FIELD REPAIR, Fairfield, Illinois

MEAD ENGINE & WELDING WORKS, Sterling, Kansas

CORNELISON ENGINE MAINTENANCE CO., INC., Seminole, Oklahoma

ROGERS DIESEL ENGINEERING CO., New Orleans, La.

NORDBERG

DIESEL and GAS ENGINES

POWER CHIEF

4-657-O

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New Equipment

Slim-Hole Drift Indicator

A new drift indicator, especially designed for use in slim hole drilling and workovers, has been announced by Garrett Oil Tools. Called the Sure-Shot Model A, the indicator is especially useful where small diameter drill pipe is employed. The tool measures only 1⅜-in. OD and can be run inside any 2-in. or larger drill pipe with a bore of 1¾ in.

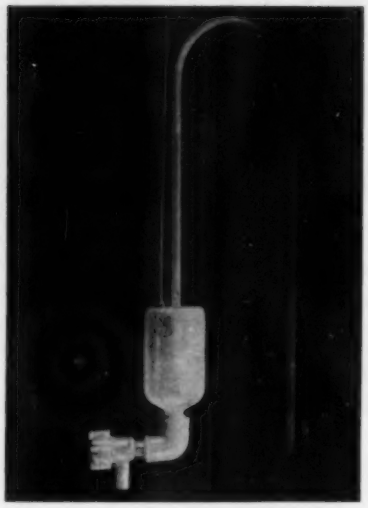
To make recordings, the indicator uses a plumb bob and an aluminum disk marked with circular grooves. The slope angle is recorded on the disk with an indentation made by the pointed end of the plumb bob. The tool may be dropped as a go-devil or run on a sand line or small diameter wire line. Optional top connections permit recovery with a core-barrel overshot or any of the standard overshots used on small diameter measuring line. *Garrett Oil Tools, Inc.*

Circle number (8) on reply card.

Polyethylene Syphon Is Self-Priming

An all-polyethylene syphon with a built-in "self-starter" is available from General Scientific Equipment Company. The syphon consists of a semi-rigid U-tube which has an open end and a flexible squeeze bulb attached to the other end. The squeeze bulb has a stopcock outlet. Squeezing the bulb primes the syphon by forcing air out of the open end into the liquid. When the bulb is released, the partial vacuum created sucks the liquid into the open end.

The syphon comes in 2 sizes. Size 1 has a ½-in. ID tube for use with large



drums and carboys. Size 2 has a ¼-in. ID tube for use where a slower flow is suitable. *General Scientific Equipment Company.*

Circle number (9) on reply card.

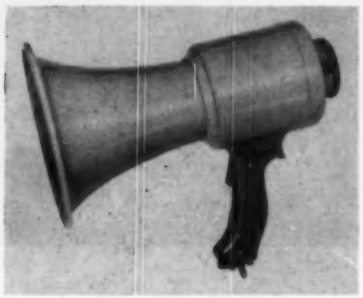
Plunger Features Wobble Washers

Spring-loaded wobble washers comprise the key feature of a new oil and gas well plunger introduced by the Harold Brown Company. While wobble washers were employed on the predecessor model plunger, they were free-floating. The spring-actuated washers affect an even tighter seal with the tubing wall and remove paraffin more efficiently. There are 24 wobble washers in the plunger and they ride the tubing wall continuously, wiping fluid into the seal section of the plunger. This also prevents soft paraffin from hardening on the tubing wall. *Harold Brown Company.*

Circle number (10) on reply card.

Transistor-Powered Portable Megaphone

A new transistor-powered Audio Hailer portable megaphone, which projects speech over half a mile, is announced by Audio Equipment Company, Inc. The unit is completely self-contained and operates on standard flashlight cells. Other



features are anti-feedback construction, hermetically-sealed transformers, and controlled-reluctance microphone. The unit weighs only 5¾ lb, with pistol-grip for 1-hand operation. *Audio Equipment Company, Inc.*

Circle number (11) on reply card.

Entirely New!

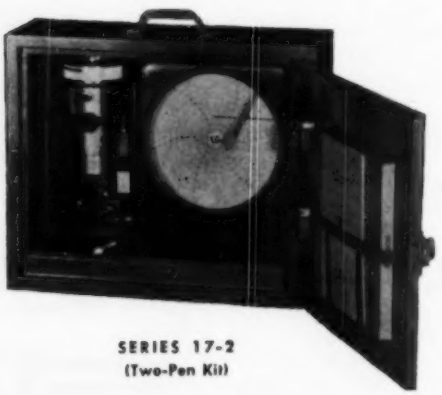
GAS-OIL RATIO KITS

The Merla Gas-Oil Ratio (GOR) kits, compactly assembled in a sturdy metal case, contain all the equipment required to take gas-oil ratio tests.

The equipment consists of a pressure recorder, complete with clock, recorder charts, ink, winding key, orifice capacity tables, 2" Merla Quick Change orifice well tester with seven orifice plates and 10' of ¼" hose with snap-on fittings. The kits are available with single or two-pen recorders in a variety of pressure ranges to cover all standard requirements.

The sturdily constructed steel case protects the equipment during storage, transportation, and use. The presence of all required equipment is easily checked by visual inspection.

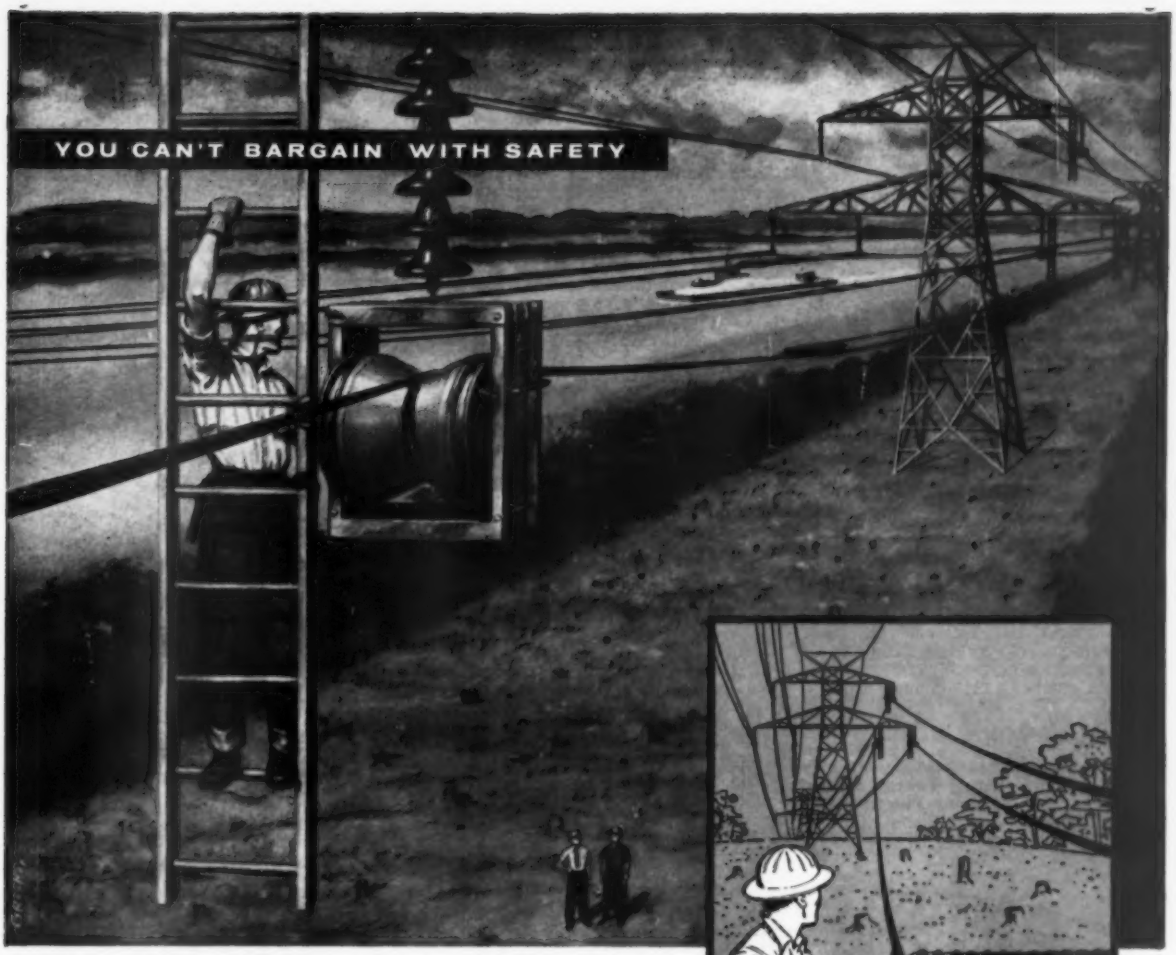
Write for descriptive folder No. 558



SERIES 17-2
(Two-Pen Kit)

MERLA TOOL CORPORATION 9223 BURRUS ST. DALLAS, TEXAS, P. O. BOX 2576

PHONE: FLeetwood 2-1754 • *Contact your nearest Merla Distributor or your favorite supply store.*



Stringing conductors on towers carrying a live 330,000 volt circuit is a tough job. Hoosier Engineering Company of Columbus, Ohio, does it by threading conductors up to 1¾" through a tension machine and pulling them over sheaves on the tower arms with 9000 foot lengths of Wickwire Wire Rope. On jobs like this, where men's lives are at stake . . .

rope failure can be fatal

Whether you're stringing power lines, pulling drill pipe, or handling other hazardous hoisting jobs—don't bargain with safety. "Bargain" wire rope can cause more trouble and expense than you expect. Buy wire rope on the basis of *quality* . . . buy Wickwire Rope.

For extra strength—buy Wickwire's Double Gray IWRC extra improved plow steel wire rope

WICKWIRE ROPE — A CF&I PRODUCT

CF&I

LOOK FOR THE YELLOW *TRIANGLE*

PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION

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5924

New Equipment

Disposable Plastic Gloves

New plastic gloves, rugged enough to be re-usable and inexpensive enough to be disposable, are announced by Plasticsmith, Inc. The gloves, available in large, medium, and small sizes, are packaged in rolls of 12 to 1000. Known as Handgards, the gloves are made of 1¾-mil polyethylene material, heat sealed by a machine which insures a waterproof product. The

gloves are pre-talcumed for ease in sliding on and off. Industrial gloves of heavier weights, longer lengths, with perforated backs for additional ventilation, or any special color or design can be provided. *Plasticsmith, Inc.*

Circle number (12) on reply card.

Pilot Liner Mill

A new liner mill has been announced by Kinzbach Tool Company. Interchangeable blades fit a wide range of bodies for use in different sizes of pipe. Blades may be easily replaced in the field.

Incorporated in the blades are end extensions for drilling packed accumulations in the pipe to be cut, guide surfaces for piloting within the pipe, a substantial length of cutting section faced with sintered tungsten carbide aggregate, and a protective bearing surface to prevent cutting section contact with the casing through which the tool is run. As the cutting section of the blades is expanded, the condition is signaled by restricted circulation resulting from the enlarged shoulder on the body of the tool coming into contact with the end of the pipe being cut. *Kinzbach Tool Company, Inc.*

Circle number (13) on reply card.

Retrievable Cup-Type Bridge Plug

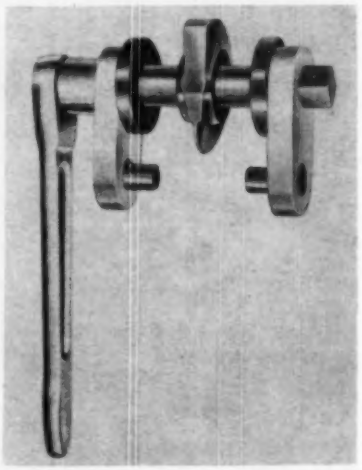
An easily retrievable cup-type bridge plug, developed by Halliburton, eliminates the need for pump trucks during setting operations and is especially designed for high pressure holes. The new bridge plug may be run in alone on tubing when a temporary plug is needed for down-hole operations. One of it's major functions, however, is for running with a suitable tool, such as the company's retrievable test-treat-squeeze packer, for isolation of zones to be tested, treated or squeezed.

The plug's operation is such that setting and retrieving is compatible with the operation of the RTTS packer. This combination permits straddling desired zones, so that several may be isolated individually for treating or testing, with only one trip in the hole. *Halliburton Oil Well Cementing Company.*

Circle number (14) on reply card.

Tool Spreads Flanged Pipe Connections

A new tool for spreading flanged pipe connections is being manufactured by Wm. L. Riggs Company. The tool, named "Safety Boy," features a circular cam wedge which, with the use of a ratchet handle, provides a lightweight tool for spreading flanges in a matter of seconds. The tool is anchored onto flanges by insertion of pins into flange bolt holes while



at the same time inserting tapered edge of circular cam wedge into small opening between flanges. *Wm. L. Riggs Company.*

Circle number (15) on reply card.

OPERATOR JUST CALLED...SAID SEECO-MUL DID SUCH A GOOD JOB ON HIS LAST WELL HE WANTS TO USE IT IN THIS HOLE TOO!
"SEECO-MUL MAKES A GOOD MUD BETTER"
Garvin DRILLING COMPANY

Drilling-Producing Literature

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

New PGAC Catalog

Perforating Guns Atlas Corporation has announced the completion of their new catalog. Services, instruments, and tools of the company are fully illustrated in the catalog which includes sections entitled, "Strata-Test Formation Fluid Sampling Service," "Induction-Electrical Logging," "Nuclear Well Logging," "Electrical Well Logging," and "Perforating Techniques and Applications." The last section is of particular interest to operators who are confronted with the problem of choosing between bullets and jets for their perforating jobs. Some of the other perforating subjects discussed in that section are penetration problems, acidizing, economics, fracturing problems, casing-size problems, well temperature problems, combination bullet and jet perforating, and evaluation of perforating equipment. *Perforating Guns Atlas Corporation.*

Circle number (16) on reply card.

Rotary Equipment Catalog

A new catalog, descriptive of its complete line of portable rotary drilling equipment, is announced by Davey Compressor Company. Features include over-all rig photographs, sectional views of individual operating mechanisms and action pictures. Complete specifications are presented on 6 standard rotary drills. These include an air-blast unit, a mud fluid rig, and 4 combination air compressor-mud pump machines. Five drills are truck-mounted and offer the option of power take-off or separate engine drive. One drill is designed for crawler tractor mounting. *Davey Compressor Company.*

Circle number (17) on reply card.

Oilfield Water Consulting Service

Complete oilfield water consulting service available to the industry is described in a new bulletin that highlights services of Bradford Laboratories. The laboratories maintain oilfield water conditions that assure maximum oil removal, and minimize gyp deposits, corrosion and organic growths in both input and production wells. A portion of the bulletin describes services offered by Bradford field engineers.

Six case histories of services are included in the bulletin, describing waterflood problems ranging from severe leakage in water lines to plugged, corroded water systems. *Bradford Laboratories.*

Circle number (18) on reply card.

Service Stores in Venezuela

Of particular interest to operators in Venezuela is a booklet prepared by The National Supply Company entitled "At Your Service in Venezuela." The booklet illustrates and describes the operations of the company's stores and shops located in that country. Also included is a partial listing of the thousands of items maintained in stock in the various stores located in Venezuela's producing fields. *The National Supply Company.*

Circle number (19) on reply card.

Fire Protection Booklet

A complete manual of industrial fire protection has been published by Grinnel Company, Inc. The 42-page booklet, entitled "Special Hazard Fire Protection," treats the subject of fire protection from a simple description of the fire burning process to descriptions of the most elaborate fire control systems. Many illustrations accompany sections in the booklet dealing with water spray systems, foam systems, carbon dioxide systems, and dry chemical systems. Also included is a chart used in selecting the correct fire control system recommended for various types of fire hazards. *Grinnel Company, Inc.*

Circle number (20) on reply card.

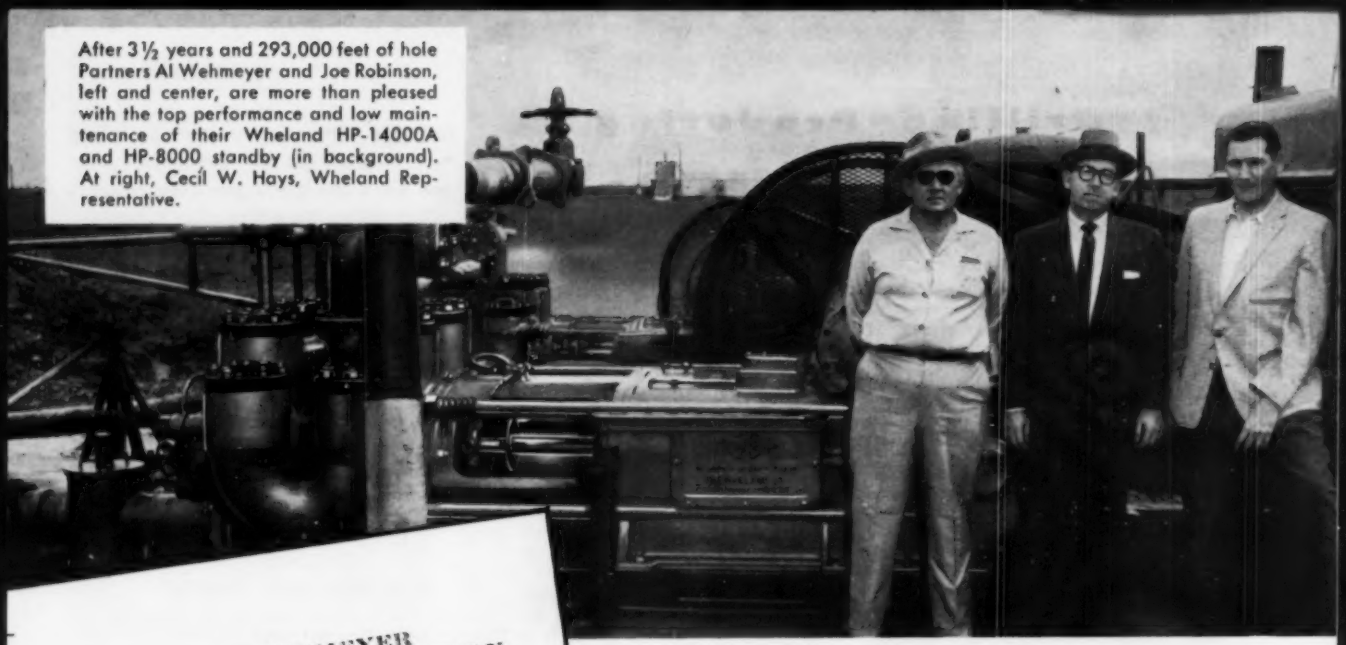
use Seeco-Mul *for better drilling... better completions~*

Next time you're on a tough well, convert to a Seeco-Mul emulsion mud and watch your hole troubles disappear. Seeco-Mul makes faster drilling, reduces friction on the drill stem, provides a higher velocity of fluid on bottom, and allows pump pressures to be lowered and more evenly sustained. A Seeco-Mul mud also forms a tough, thin wall cake, it protects the pay zone from water, and reduces interfacial tension. Seeco-Mul is exceptionally stable at high temperatures, it is readily soluble in cold water, and it works well at high pressures. You will minimize hole enlargement, too, and your well will come in on production better, easier, and cleaner.

Any qualified mud engineer can use Seeco-Mul without extra equipment or special instructions. Just add it to the system (usually 2 to 3 lbs./Bbl.) through the hopper or the mud hog suction over one or two circulations. Seeco-Mul is packaged in sturdy, moisture-proof 50-pound sacks that are easy to handle around the rig.

Your local mud dealer will be glad to tell you about many other advantages of a Seeco-Mul emulsion mud, or write to us for illustrated literature and a lab sample. We'll be glad to send you full particulars without obligation. Crossett Chemical Company Division of The Crossett Company, P. O. Box 271, Crossett, Arkansas.

get a better hole with Seeco-Mul *emulsifier*



After 3½ years and 293,000 feet of hole Partners Al Wehmeyer and Joe Robinson, left and center, are more than pleased with the top performance and low maintenance of their Wheland HP-14000A and HP-8000 standby (in background). At right, Cecil W. Hays, Wheland Representative.

ROBINSON-WEHMEYER
DRILLING & EXPLORATION

5122 BROWNCROFT HOUSTON 21, TEXAS

March 31, 1958

Mr. Gordon P. Street, Pres.
The Wheland Company
Signal Mountain Road
Chattanooga, Tennessee

Dear Mr. Street:

During the past 3-1/2 years our Wheland HP-14000A pump and Wheland HP-8000 standby have made some 293,000 feet of hole. Service and repair expense have been nominal and we are more than pleased with these pumps.

Our operations are in the Texas Gulf Coast area. We drill in depths from 3,000 to 6,000 feet on contract, interest deals and for our own account and we can always depend on our Wheland pumps for a good job under all drilling conditions.

Very truly yours,

Joe Robinson

Joe Robinson

WHELAND

DUPLEX SLUSH PUMPS

Always do a Good Job!

"...can always depend on our Wheland pumps for a good job under all drilling conditions."
—Mr. Joe Robinson

HP-14000—7½" x 14", 350 HP Nominal Input at 60 RPM. Discharge Pressure with 7½" liner 838 PSI; with 5½" liner, 1627 PSI.

HP-8000—7¼" x 12", 220 HP Nominal Input at 70 RPM. Biggest little pump on the market!

DEPENDABLE SERVICE . . . LOWER MAINTENANCE

Write today for detailed bulletins on the Complete Line of Wheland Slush Pumps

WHELAND

ROTARY DRILLING MACHINERY

THE WHELAND COMPANY

CHATTANOOGA, TENNESSEE, U.S.A.

DRAW WORKS • SLUSH PUMPS • ROTARIES
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New Literature

Prestressed Cylinder Piles

A new 26-page catalog describing design, construction and installation of prestressed concrete cylinder piles is available from Raymond International Inc. The literature points out that more than 300 structures have been built in recent years on Raymond prestressed cylinder piles. Among the more significant structures illustrated are offshore drilling and production facilities in Lake Maracaibo and the Gulf of Mexico. *Raymond International Inc.*

Circle number (21) on reply card.

Circular Slide Rule

General Industrial Company has introduced a handy circular slide rule for engineers and for other plant and office executives. Anyone who must perform simple calculations will find this pocket-size calculator useful in his work.

Operation of the rule is simple and the results are accurate. To multiply, divide

and find proportions is easy and fast with this convenient circular rule. Complete easy-to-follow instructions will be included with each slide rule. *General Industrial Company.*

Circle number (22) on reply card.

West Texas-New Mexico Log Catalog

West Texas Electrical Log Service has published the 1958 edition, Volume No. 3, of its log catalog. Logs released from January 28, 1957, through January 27, 1958, are included in the listing, which covers electrical and radioactivity logs run in the West Texas, New Mexico and West-West Central Texas borderline counties. Logs are listed by county, divided between wildcat and field wells. *West Texas Electrical Log Service.*

Circle number (23) on reply card.

Expansion Joint Catalog

Badger Manufacturing Company announces a new 80-page catalog covering Badger S-R expansion joints. The publication includes complete information for rating expansion joints subjected to axial or lateral movement, angular rotation or combinations of these movements, together with formulae and tables for calculating the forces and/or bending movements developed in the connected piping or equipment.

Also included are tables of dimensions and weights for expansion joints from 3 in. to 72 in. in diam, as well as other engineering data required to select, order and install expansion joints. *Badger Manufacturing Company.*

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To prevent plugging of the center section . . . *a common problem with conventional diamond bits* . . . the new HYCALOG bit actually cuts a small core. Then, by a combination of hydraulics and bit design, the core is broken off in short segments and washed through the V-DOOR slot out of the hole. As a result of this design, far more hole per trip than ever before possible has been made in these extremely hard formations.

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106

10,680-Acre Waterflood Underway in Oklahoma

THE FIRST PHASE of the largest waterflood project in the Golden Trend oil area of southern Oklahoma has been launched by Sinclair Oil & Gas Company, largest interest owner, who will operate the unit.

The big secondary recovery project, known as the Southeast New Hope Gibson Sand unit, is located near the town of Lindsay. All or parts of 23 sections in townships 4n-3w in Garvin County and parts of four sections in 5n-3w in McClain County are included in the 10,680-acre unit.

The unit, approved by the Oklahoma Corporation Commission May 27, embraces a portion of the Golden Trend Gibson Sand pool. Adjoining the Southeast New Hope Gibson Sand unit to the south is the Southwest Antioch Gibson Sand unit, created by the Corporation Commission January 6, 1948, which through subsequent enlargements includes 9520 acres.

Sinclair owns approximately 30 percent interest in the new unit. Other major working interests are owned by The Texas Company, 18 percent; Skelly Oil Company, 9; Phillips Petroleum Company, 6, Sunray Mid-Continent Oil Company, 5; Cities Service Oil Company, 5; Magnolia Petroleum Company, 4, and Vickers Petroleum Company, 3 percent.

The Southeast New Hope Gibson Sand unit is part of a stratigraphic trap on the southwest flank of the Pauls Valley uplift. The field was opened in the summer of 1947, with the discovery well in NW SE 4-4n-3w, Garvin County. By the end of 1952, the field had been extended to include 10,680 productive acres, with 245 wells producing from the Gibson sand.

Initially, the Southeast New Hope Gibson sand reservoir was estimated to have contained 75,000,000 bbl of oil in place. The field has produced approximately 14,500,000 bbl of oil. Estimated additional recovery by waterflooding has been set between 8,000,000 and 10,000,000 bbl.

Current daily average production is about 750 bbl, with approximately half of the original wells now being nonproductive, having reached their economic limit.

The Gibson sand in the Southeast New Hope field is found at an average depth of 7000 ft, with an average thickness of 12½ ft and range from 5 to 50 ft.

The initial stage, to be developed by 80-acre 5-spot patterns, will consist of 1680 acres. Twenty-one wells will be converted to water injection, with water to be obtained from Permian sands underlying the area. Approximately 12,000 bbl of water per day will be injected during development of the initial phase. Oil will be produced from 20 wells.

Complete development of the unit by waterflooding will take from four to six years, according to the operators' committee.

While not involved in the unit operations, other sources of supply found productive within the unit area are Hart, Viola, Hunton, Bromide and Oil Creek formations.

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the Refining Engineer

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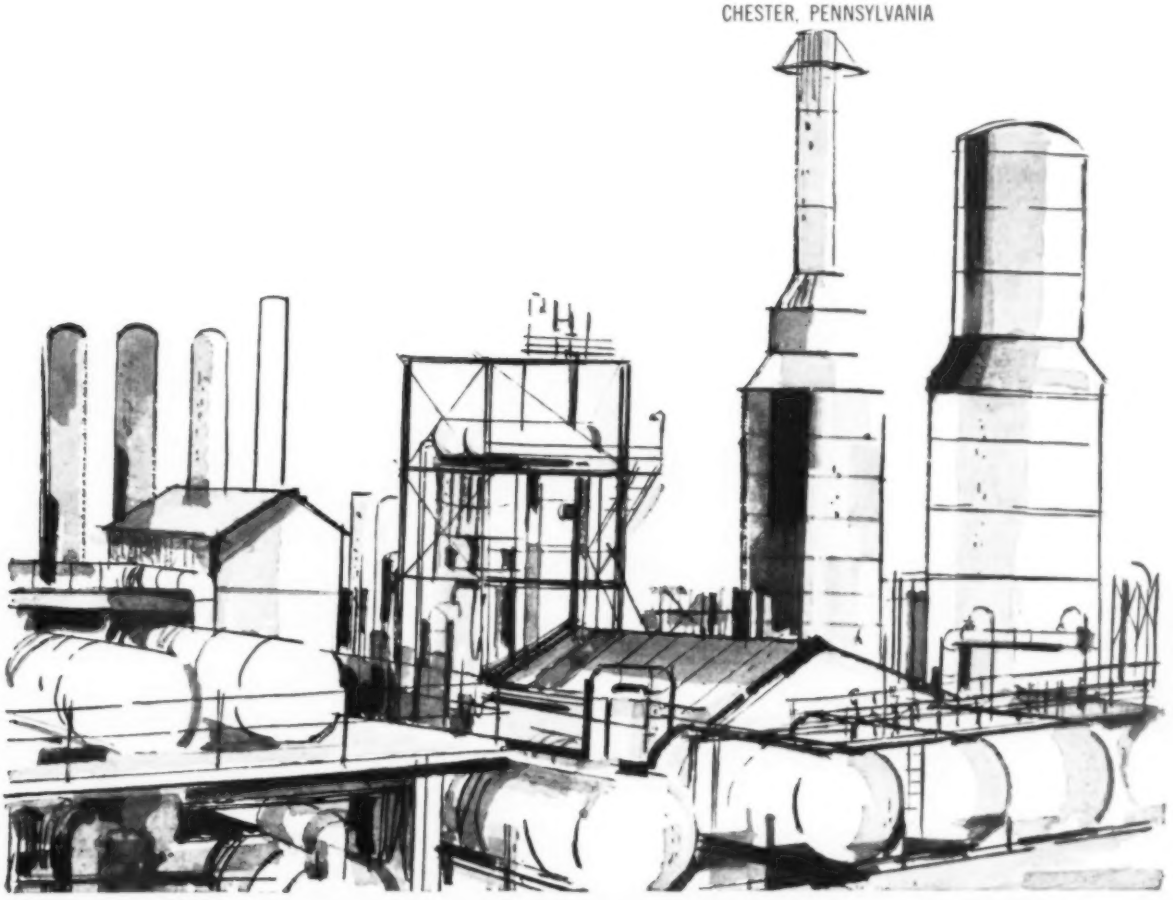

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BLAW-KNOX

New Projects

the Refining Engineer

. . . in Petrochemicals

Facilities to complete a glycerine production program are slated for Shell Chemical's Norco, Louisiana, plant. To cost $10-million plus, one unit will make acrolein, another will convert acrolein and hydrogen peroxide to glycerine. H_2O_2 will come from a unit completed earlier this year. Company is now marketing H_2O_2, plans to make large quantities of acrolein . . . a chemical not presently made in large volume. Late 1959 completion is scheduled.

Tentative plans for a 73,000 ton per year urea plant, at Marcus Hook, Pennsylvania, have been announced by Sun Oil Company and Olin Mathieson Chemical Corporation. Companies have exchanged letters of intent to form a joint operating company, with further details not yet finalized. Sun's large Marcus Hook refinery includes a 300 ton per day ammonia plant, which would be the raw material source for urea manufacture.

Increase in conversion of raw petroleum into pure carbon for electrodes by 720 tons a day has been announced by The General Carbon and Chemical Company. Feature of the calcining plant is a combustion system that is automatically controlled to maintain a predetermined hot zone temperature through use of an electronic eye that senses slight temperature changes.

Synthetic rubber production facilities are being expanded by Goodrich-Gulf Chemicals, Inc. at their Institute, West Virginia, plant. Million dollar expansion will increase plant's production of crumb rubber, mastics and adhesives. An extruder dryer for production of high quality extrusion-dried, electrical-grade rubbers and other special polymers will also be installed. Construction started in June, will be completed in September.

Work on new hydrogen plant for Kali-Chemie A.G., Hannover, Germany, has begun. Unit is based upon liquid hydrocarbon feedstock and comprises a tubular cracking furnace followed by carbon monoxide conversion, carbon dioxide removal and a methanation stage.

. . . in Gas Processing

Saskatchewan's second natural gasoline plant will be built in the southeastern region of the Canadian province for Steelman Gas Ltd. Larger than the other plant, initial capacity will be 25 MMcf per day with provision being made for later expansion to 45 MMcf daily. Cost of the plant, its gathering system and a pipeline to Regina will be $16-million.

Construction is underway for Pan American's new gas processing plant, north of Monahans, about 35 miles west of Odessa, Texas. A 1320 hp compressor will power the compression-refrigeration type plant. Initial capacity will be 4 MMcf daily, ultimate feed rate 12 MMcf per day. Completion is planned for November.

A 35 MMcf per day natural gasoline plant is abuilding for Anchor Gasoline Corporation at a site eight miles west of Mission, Texas. November completion is planned for the plant, which is to be designed for future expansion to 45 MMcf daily.

. . . in Refining

Lube oil manufacturing facilities will be expanded at Shell Oil's Wood River, Illinois, refinery. This and certain improvements will increase high VI oil output up from 2000 to 4000 bbl per day. Two new process units will be built and present dewaxing and deasphalting units will be expanded. Completion is programmed for mid-1959.

A new crude distillation unit will increase capacity from 44,000 bbl per day up to 62,000 bbl per day at British Petroleum's Grangemouth (Scotland) refinery. Unit is part of BP's $17-million expansion of the refinery, will be completed late this year.

Skelly Oil's El Dorado, Kansas, refinery will be modernized and capacity boosted to 50,000 bbl daily—a 25 to 35 percent increase. New units include HF Alkylation, a 12,000 bbl per day vacuum distillation unit to make asphalt and coker feedstock, and a 500 ton per day delayed coking unit.

A distillate hydrodesulfurizer is to be built at Shell Oil Company of Canada's North Burnaby, British Columbia, refinery. The trickle-type unit will cost $2-million, is scheduled for February 1959 completion.

More than $3-million is being spent by Imperial Oil, Ltd. for a Powerformer at its Regina, Saskatchewan, refinery. Construction contract has just been awarded, with completion planned for near the end of this year. Company will also spend about $3-million during the next four years to modernize and enlarge its Lakehead District headquarters.

Standard of Indiana is adding a 1630 bbl per day hydrofluoric acid alkylation unit to its Mandan, North Dakota, refinery. The Phillips'-licensed unit will be ready for operation this fall.

Alkylation unit nears completion at British American Oil Company's new Vancouver, B. C., refinery. Tower at right is part of gas recovery section for the catalytic cracker. The 20,000 bbl per day completely integrated refinery will be completed early this fall, within a year of initial foundation formation. Canadian Kellogg, constructors for the refinery, recently won an award for 16,573 man-days of accident-free time. Process units at the refinery include crude topping, vacuum distillation, catalytic cracking, catalytic reforming, hydrodesulfurization and alkylation. Crude will come from Alberta via the Trans-Mountain pipeline.

Ethyl creates new tools for research

Instruments of variety and sophistication are developed in a continuing effort to learn more about combustion

ETHYL SCIENTISTS must be able to "see" what is happening inside an engine in successive millionths of a second to study such momentary phenomena as knock, wild ping and rumble.

Standard devices for measuring combustion phenomena frequently are not fast enough. Ethyl's progress in combustion studies sometimes seems to have outrun the capacities of commercial instrumentation that is available today.

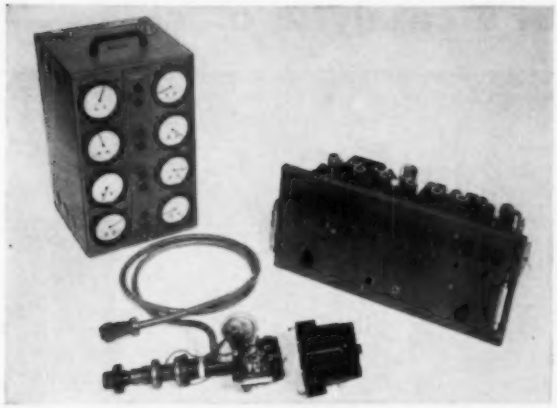
Therefore, in Ethyl's Detroit Research Laboratories, existing instruments are often modified for special requirements and new ones are created when needed.

THIS INGENIOUS DEVICE—a surface-ignition analyzer—looks at eight ranges of crankshaft rotation in five-degree increments and counts the number of surface-ignitions that occur in each range.

Using it, Ethyl research engineers proved that fuels of different composition tend to surface-ignite at different times in the engine cycle.

This technique also enabled better, quicker evaluation of the effect of gasoline additives such as phosphorus in reducing surface-ignition.

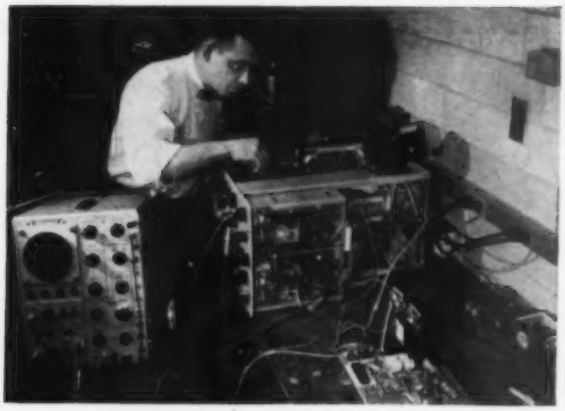
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



EACH CYLINDER in a multi-cylinder engine must reveal its own story during operation if surface-ignition problems are to be diagnosed correctly.

Several years ago, the device on the left was developed by Ethyl instrument engineers to count the number of surface-ignitions that occur in each cylinder.

Now, a new improved model, seen at right, provides digital counter readings for each surface-ignition event. The modified ignition distributor triggers the counters to operate at the proper time in the engine cycle.



ETHYL RESEARCH ENGINEERS in basic combustion wanted to observe four engine variables at the same time, using a single electron gun oscilloscope.

Since such an instrument was not available, Ethyl instrument engineers proceeded to modify a well-designed commercial model for this special purpose.

The resulting instrument, using high-speed (microsecond) electronic switches, permits continuous viewing of four separate engine events; in this case, two pressure signals and two timing signals.

THE BALANCED PRESSURE PICK-UP is a big step ahead in measuring combustion pressures accurately. But it does require another mounting hole in each combustion chamber.

An Ethyl engineer is designing this pick-up into a spark plug. The combined pick-up and spark plug can then readily be installed in the spark plug mounting hole.

ALL ETHYL CORPORATION RESEARCH findings depend upon accurate and reliable instruments, ranging from the simple glass-stem thermometer to the complex scintillation counter pictured in the photograph above.

A well-planned servicing and calibration schedule keeps hundreds of sensitive instruments "on the beam."

How Ethyl Research is helping you

By keeping alert to new instrument possibilities and techniques, Ethyl Research people are able to increase their own effectiveness and help expand the Oil Industry's knowledge of fuels, engines and combustion.

Ethyl Research Representatives are available at all times to give your people the benefit of our specialized knowledge in measuring combustion phenomena and other phases of fuel-engine research.

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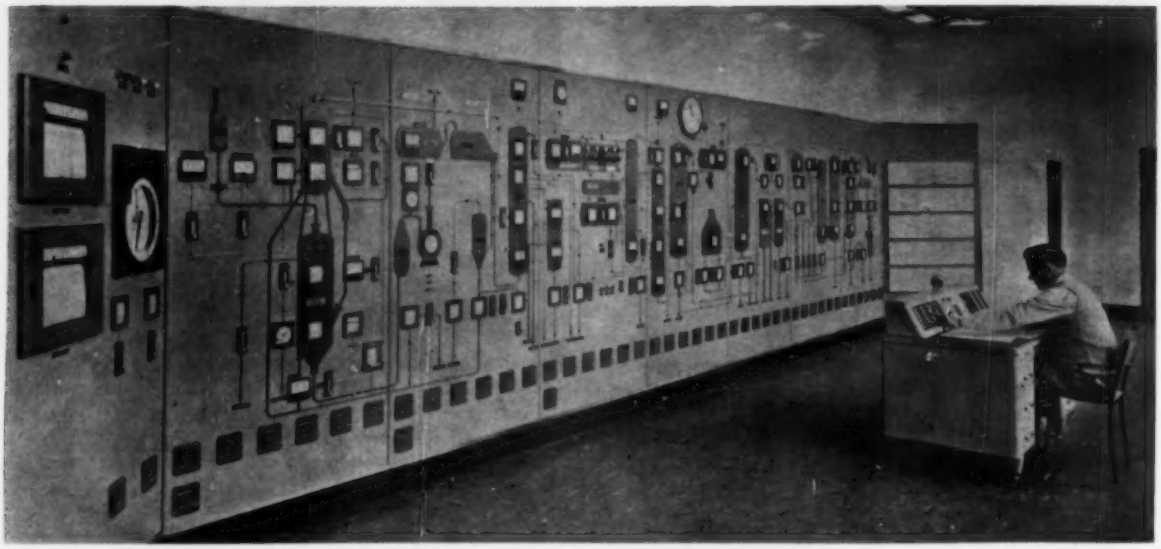
Installed for the first time on a catalytic cracker . . .



This all-electronic control panel is nerve center for Regent Refining's new catalytic cracking, gas recovery, fractionation and polymerization units. Hydraulic control valve operators are used throughout.

ELECTRO-HYDRAULIC CONTROL . . . . . HOW WELL DOES IT WORK?

Clifford D. Gingrich
Regent Refining (Canada) Limited
Port Credit, Ontario, Canada

FIRST APPLICATION of all-electronic instrumentation to a fluid catalytic cracking unit was made at 25,000 bbl per day Port Credit, Ontario, refinery of Regent Refining (Canada) Limited. Onstream since late last year, operating experience at the new 7000 bbl per day cracking unit and its auxiliary processing sections have caused us to feel that electronic instrumentation has many advantages. Greatest reservation — hoped to be overcome by installation of our own motor-generator unit — is that a reliable source of electric power be available at all times.

Here's a full report on how we decided upon all-electronic instrumentation, how it works, how it was applied to the new fluid catalytic cracking unit, operating experience gained thus far, and how cost of installation and operation compares with other systems. Also, operation of an electro-hydraulic control loop is described.

Testing ground for electronic instrumentation was a new crude distillation unit, completed in 1955. Pneumatic control valves only were available at that time; electro-pneumatic units were therefore mounted at each valve to convert electrical output of the controllers to a pneumatic signal to drive the valve motors.

Adapted from a paper "Electronic Instrumentation at Regent Refining (Canada) Limited's Port Credit Works," presented by Mr. Gingrich at Mid-Continent Regional Meeting of Western Petroleum Refiners Association, Wichita, Kansas, June 26, 1958.

Little or no difficulty was experienced during crude unit startup. Further, experience from then on indicated that electronic controls could do an outstanding job reliably — with only simple maintenance.

One of the few bugs that materialized occurred during a cold snap in fall 1955, before the unit was completely winterized. Fluid in the differential pressure transmitters became very viscous, and the operators put steam hoses on them. Three transmitters failed when the bodies filled with water. These have since been replaced with hermetically sealed units which can operate completely filled with water.

An electro-hydraulic operator was installed on the main tower top reflux temperature controller of the crude unit in 1956. Operation was so good that it was decided to couple electronic instrumentation to these electro-hydraulic operators and build them into design of the new 7000 bbl per day fluid catalytic cracking unit.

Electronic Restart and Shutdown — in a Hurry!

Automatic motor restarting made possible. Practically all drivers for the FCCU and its auxiliary facilities are electrically powered (see Design and Operation). Power is supplied to the refinery through two 22,500-v feeders . . . one operating, one standby. Automatic transfer switchgear is provided to protect for normal feeder outage.

Since electronic instrumentation at the FCCU has

Design and Operation of Regent's New FCCU

Design charge rate of the UOP-design catalytic cracker is 7000 bbl per day of atmospheric and vacuum gas oil at 26-27 API, with design conversion level at 70 percent. Basic equipment includes, of course, reactor, regenerator, boot stripper and cyclone separators. A waste heat boiler recovers heat from flue gas and reactor products.

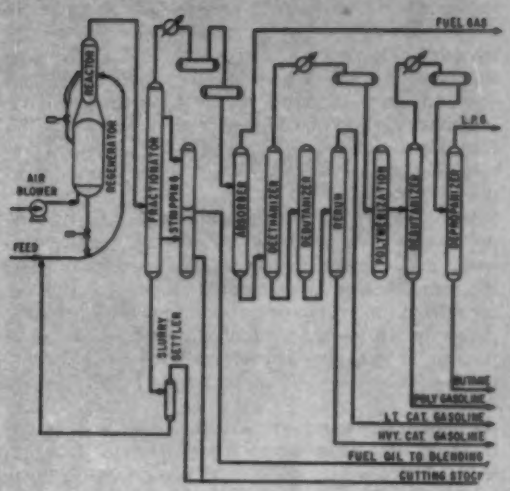
Fractionator products include gas and gasoline taken overhead; light cycle gas oil cut for furnace fuel oil; heavy cycle gas oil cut for recycle to the reactor, gland oil for pumps and instruments, and as cutter stock for bunker fuel oil. Catalyst recovered from slurry settling facilities . . . a vessel separate from the main fractionator . . . is recycled to the reactor, with clarified oil used in bunker fuel oil blending.

Gas concentration equipment comprises compressors, gasoline and gas oil absorption, deethanizing, stripping and debutanization. Debutanized gasoline is split into light and heavy component for octane and volatility adjustments in a rerun tower, heat for which is supplied by a fired reboiler. Light and heavy gasoline fractions are caustic-washed and inhibited before blending into finished gasoline storage.

The polymerization unit consists of charge caustic and water-washing facilities, a single-chamber reactor, debutanization, propane-butane splitting and propane drying. End products are commercial LPG, polymer and butane for gasoline blending.

Caustic neutralization facilities are used for disposal of spent caustic from poly plant charge and furnace fuel oil treating. Heart of the system is a stripper that uses FCCU flue gas to neutralize the caustic, reduce phenol concentration and strip out hydrogen sulfide.

Waste water disposal is effected by stripping water from poly plant charge treating, furnace oil treating



and various decanter drains with steam and FCCU flue gas. Hydrogen sulfide and ammonia are removed and phenols concentration lowered. Subsequent absorption of phenols in crude oil by use of this stripped water in the crude oil desalters serves to complete elimination of objectionable quantities in refinery water effluent.

Electricity is the primary power source for these units. The main air blower, gas compressors and poly charge pumps are electrically driven, have no spares. All normal operating pumps are electrically driven, have steam standbys . . . the only exception being the slurry reflux pumps. These are steam-driven and supply 50 psig exhaust steam for catalyst and gas oils stripping.

high rate of response, an automatic sequential restarting scheme that enables transfer of main power feeders was made feasible. Result is that entire refinery load is not transferred at one time and no interruption to continuity of FCCU operation is caused.

How the restart system works. After a momentary power outage such as would result from feeder transfer, process pump drivers remain connected to the line through time delay-relays on starter under-voltage dropouts.

The main air blower and gas compressor motors are, however, disconnected from the line on instantaneous under-voltage, for a period sufficient to allow the process pumps to re-accelerate and resume drawing normal current. The gas compressors, which are automatically unloaded by sequential valve lifters with failure of motor drivers, then automatically restart, accelerate to normal operating speed, and are reloaded. When this sequence is completed, the air blower . . . which has been unloaded by automatic closure of inlet guide vanes . . . restarts automatically, accelerates and is reloaded.

Air blower control. Closure of the air blower inlet guide vanes is effected by interruption of the signal output from an electronic flow controller. In this case the operator, which directs flow of oil to the power cylinder of the inlet guide vanes, assumes its emergency position. When the signal output is thus interrupted, it is transferred to a dummy load resistor so that the control remains in balance throughout the time the signal is disconnected from the receiving element. When reconnected, there is a minimum of hunting in the control before normal flow is restored. Experience with this system has shown that within two seconds of transferring the controller output to the inlet guide vanes operator, flow of air to the regenerator is completely stabilized.

Slide Valve Control

The regenerated catalyst slide valve is positioned by the reactor temperature controller and the spent catalyst slide valve position is controlled by reactor bed level. Both slide valves are equipped with overriding differential pressure controllers. These differential pressure controllers are set so that if the temperature control or reactor bed level control were to require the valve to open sufficiently so that differential pressure would be lost or, if the differential pressure for any reason drops below a minimum set by the operator, the overriding control will take over the valve and hold it's position such that a differential pressure of, say, 2 psi will be held across the valve, regardless of reactor temperature control or reactor bed level controller requirement.

Mechanics of the system. Slide valve positioners are arranged so that at a signal of 4 ma the slide valves will be closed and at 8 ma wide open. An override

adapter is provided on the output line to the slide valve positioner. It selects the lowest output of the two controllers, that is, the reactor temperature controller or the pressure differential controller. As long as the differential is above 2 psi, output of the differential pressure controller will be 8 ma and the selector will direct output of the temperature controller to the slide valve. If differential pressure falls to 2 psi, output from this control will fall to below that of the reactor temperature control and the slide valve will be positioned by this instrument.

System has proved reliable. A transition from temperature or level control to differential pressure control is much smoother than standard operation where the operator would be required to swing his instrument from the automatic position to control the valve manually. He would invariably overshoot the valve position required to maintain differential and cause the unit to go into an unnecessary perhaps severe upset.

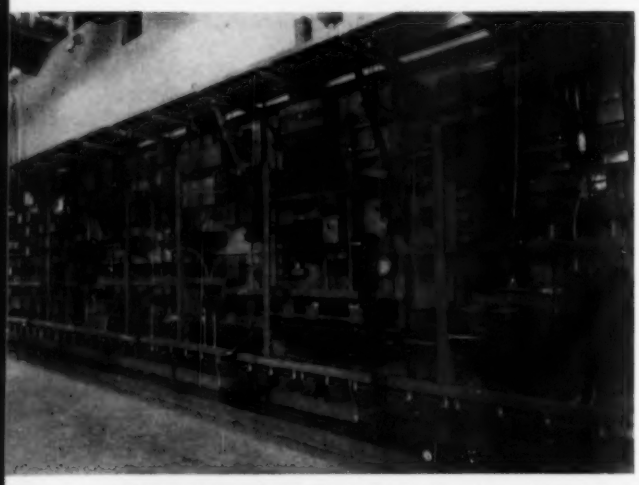
An automatic shutdown and steam-out system, actuated by failure of the main air blower, is also provided. This has been effected by use of signal opening relays on outputs of key controllers. When the main air blower fails, a signal opening relay opens the circuit on output of the fresh feed controller and shuts off feed to the unit. At the same time relays cut off recycle to the reactor, open dispersion steam to the reactor riser, shut off torch oil to the regenerator, close the two slide valves, open the stack slide valves and release reactor pressure to the flare.

High Sensitivity and Response Observed

Electronic controls are inherently possessed of much higher sensitivity in all components than pneumatic instruments. There is little if any mechanism in electronic control, since any mechanism involves some finite friction and consequent dead spot, it follows that electronic control should basically out-perform pneumatic control equipment.

In straightforward terms, the sooner an upset is detected and action is taken to bring the condition back to normal, the smaller the off-normal valve will be and the shorter its duration will be.

This has been reflected at Port Credit by extremely stable operation in all variables: That is, although the recording elements are set for high rates of response to process changes, reactor temperature, slide valve differential and flows throughout the unit exhibit a remarkable straight line characteristic.



Back of the control panel. Simplicity and interchangeability of connections and components is one of the key features.

Meet the Author . . .

Cliff Gingrich *is general operating foreman at Regent Refining (Canada) Limited's Port Credit, Ontario, refinery. A 1948 graduate in chemical engineering from Queen's University, he has had diversified experience in process engineering, operating design, construction and initial start-up operations of several process units. A major part of his career has been with McColl-Frontenac Oil Company Limited, the parent company of Regent Refining.*

Fast Reaction to Temperature Changes

Temperature control is extremely important to quality and economy in all refinery cracking and distillation operations — particularly for fluid catalytic cracking.

To achieve very close control in spite of process lags, temperature controls are generally provided with an extra degree of intelligence. Control for other variables is a proportional action whereby the controller signals the valve in proportion to actual amount of error from desired set point and a reset action by which it signals the valve in proportion to the length of time there has been an error from the set point. Temperature controls employ rate action as well . . . the controller signals the valve in accordance with rate at which the variable is changing from the set point.

In all standard temperature control equipment employed before the advent of fully electronic units, a balancing mechanism actuated the recorder in the air control system. Consequently, the temperature change was not actually transmitted immediately to the controller mechanism. Instead, it had to reach a definite magnitude to overcome friction of the instrument. As soon as this dead spot was overcome, a sudden temperature change was transmitted to the controller. The controller was therefore receiving incorrect information on the rate of change of the temperature . . . since this information was presented in the form of a very rapid temperature change, the controller would tend to over-correct in its action on the valve. As a result, rate action could never be used as intended to achieve close temperature control.

In electronic instrumentation the most minute changes of temperature are transmitted immediately to the controller and through the control networks to the valves. Signal to the valve is therefore based on a true rate of change of temperature.

This fact has definitely been reflected in operation of the Regent FCCU by the reactor temperature controller. It maintains set temperatures within very narrow limits and will vary catalyst circulation rates very rapidly and surely without upset of slide valve differentials.

Getting Ahead of Upsets

Upsets corrected before detection! As an example, recycle to the FCCU reactor, which makes up about 30 percent of total charge, has been lost several times through loss of pump suction, high exhaust steam

pressure, etc. On these occasions, adjustment of catalyst flow down the regenerated catalyst standpipe was so fast and smooth that the operator did not detect loss of this large variable in heat balance either through change in reactor temperature or change in regenerated catalyst slide valve differential pressure! Furthermore, the spent catalyst slide valve which controls the reactor bed level found its new position so quickly that no change could be noted on the reactor bed level or spent catalyst slide valve differential.

In all cases the difficulty was recognized only after seeing that the recycle flow recorder had fallen to zero or that the regenerator was out of heat balance.

Very high speed of response is another unique feature of electronic controls. In a very large percentage of refinery applications, advantages of transmission speed are not apparent, but it does offer a tremendous improvement in control applications involving runs of 500 ft or more.

In addition to reducing time in which the instrument can take corrective measure, fast response has definitely given the operators at Regent a big head start in many upsets. For instance, on loss of the main fractionator reflux pump, the signal is immediately transmitted to the control house and the operator can take immediate steps to start the spare pump.

No longer do you hear the cry "Put her on manual and catch her!" The instrument is left on automatic, the pump swung onto the line and . . . in a matter of seconds . . . the top temperature and flow have stabilized.

To demonstrate to operators that electronic control could always out-perform manual operations, the main air blower . . . a 4500 hp unit controlled by inlet guide vane position . . . was operated on manual to hold a chart reading of 2 units of air flow. Set point of the instrument was put at a chart reading of 7 and the instrument flipped to automatic position. In less than one second flow had stabilized at 7 on the chart. A challenge to duplicate this "on manual" found no takers!

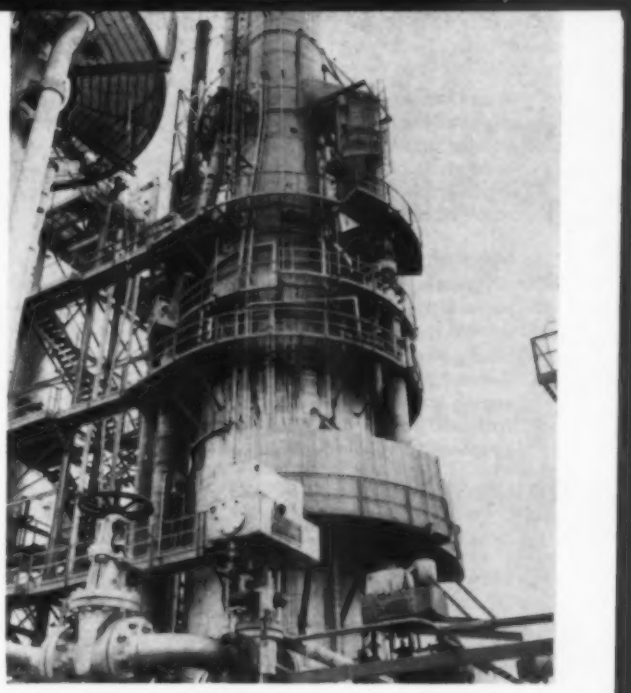
Failure? Swipe Someone Else's Component

Electronic instrumentation lends itself to a rapid checking by plug-in meters and substitution of plug-in components. In this manner the equipment is very easy to calibrate and provides much greater in-service accuracy. This plug-in feature has also been used at Port Credit when a vital instrument, such as the reactor temperature recorder, failed. A non-essential flow recorder from the poly unit board was pulled out and plugged in by the operator who once again had his vital record without having to look and wait for an instrument mechanic, even for precious minutes.

Lower Costs Claimed

Cost of electronic controls approximately equals that of pneumatic equipment. That is, cost of all components in the electronic control loop approximately equals the cost of all pneumatic loop components. There may be some variation up or down in favor of either system depending upon the particular variable involved. For example, electronic control equipment is much lower in price for temperature control if instrumentation is to be mounted on console or graphic type panels. In fact, on any measurement which must be made initially by electrical means, use of electronic control equipment for the balance of the components results in a system which is usually more economical.

In general, flow control is about equal in cost,



Design feed rate is 7000 bbl per day for the new UOP FCCU; design conversion level is 70 percent. Note electro-hydraulic valve actuators in foreground.

whereas pressure control favors the pneumatic system somewhat.

Installation cost. It is felt that electronic control can be installed more economically. This is particularly true where Division II electrical codes can be followed, as was the case at Regent. Electrical wire is far less cumbersome than pneumatic tubing since all transmitter and controller signal leads for electronic equipment may be 22 gage wire; a one-inch diameter conduit will carry 50 leads.

No accurate figures are available to me, but it has been stated that a well planned electrical panel board can represent a saving of 10 percent in fabrication cost.

Maintenance-wise, we have an investment of $135,000 in instruments. To February 1 of this year, we had spent only $550 on replacement parts. The photo of the back of the Regent panel illustrates the simplicity and interchangeability of connections and components.

Problem: Power Fluctuations

Some difficulty was encountered early in operation of the unit when the power company adjusted to load by switching capacitors in and out of the line. At these times, power surges . . . probably in the form of frequency fluctuations . . . came through to the capacitor bank of the constant voltage transformer which supplies control panel power.

These fluctuations resulted in momentary collapse of power to the instruments and caused considerable upset to the unit. At voltage collapse, all valves assume their emergency position, i.e., the slide valves close, stack valve opens, blower inlet guide vanes close, feed cuts out, etc.

This is probably one of the disadvantages of the high speed of response of the all-electronic control system. Although these voltage fluctuations were at worst of about 5 second duration, all valves had reached their final positions, and the unit had in effect shut down. When power was restored, the instruments in all cases recovered the unit within a few minutes, except

in one instance where the blower inlet guide vanes mechanically stuck at a position of about 20 percent open and the unit went into a severe upset.

Analysis of this upset later revealed that at all times the instruments functioned very well and accurately reported conditions throughout.

Solution: Own Power Supply

As a result of these upsets it is proposed to install a motor-driven generator set coupled to a gasoline-driven engine. The board will normally be supplied with power from this M-G set. On power failure to the motor, the gasoline engine clutch will engage, the engine will be cranked by a fly wheel and the controls will receive essentially constant voltage. In our proposal, purchased power will spare the M-G set through automatic transfer switches in case of failure of the unit.

Voltage drop of only 3 to 4 percent and frequency drop of about 1 cycle in switching from motor to gasoline-engine drive was demonstrated in experiments with one of these units.

Conclusion

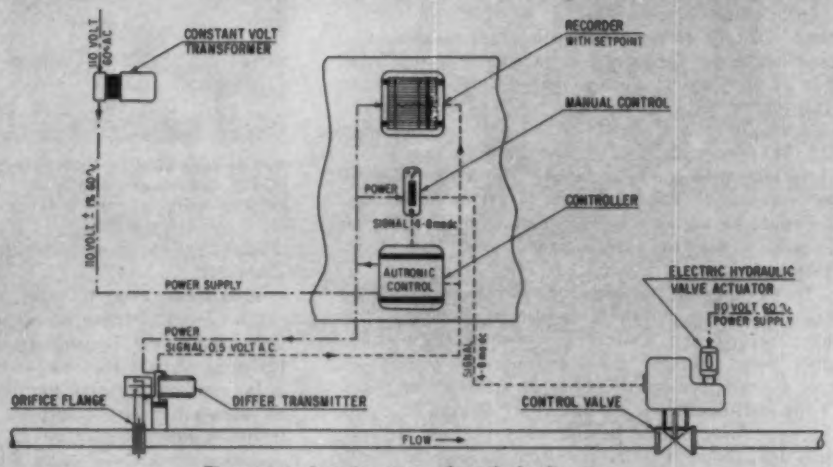
On the basis of experience gained at Regent Refining it is felt that electronic instrumentation is generally superior in performance, provided a reliable source of electrical power is available at all times.

We believe that the installation of the motor-generator power supply unit will provide this reliability, eliminating the greatest deterrent to choice of full electronic instrumentation on future units.

How the Electronic Control Loop Works

Diagram here shows how the electronic control loop works. Referring to the flow control diagram, 110-v, 60-cycle power is fed to a constant voltage transformer. This unit holds output within one percent of its setpoint . . . about 100 v.

The differential transmitter receives power from this source, fed via the mounting frames of the controllers. Movement of an iron core inside a differential transformer by deflection of the diaphragm translates the differential pressure across the diaphragm into an output signal ranging 0 to 0.5-v a-c.



Flow control system in an electrohydraulic set-up.

Recorder. This a-c signal is fed back to the mounting frame of the controller on to a rotary solenoid on the pen arm of the recorder to give flow as a percentage of the transmitter's differential range.

Set point. Power from the mounting frame of the controller is also fed to the set point unit. It is physically located in the recorder to facilitate adjustment from the panel face. This set point unit is another differential transformer with an iron core mechanically positioned to produce a reference voltage corresponding to the desired reading or differential pressure across the transmitter diaphragm.

Controller. This reference voltage is then fed back into the controller (along line not in sketch), along with the differential pressure transmitter output. These two signals then go through error detecting and amplification sections, then through a rectification section. Error is modified through the proportional, reset and rate networks, comes out of the controller as a 0-8 ma d-c signal.

Valve positioner. The d-c signal is fed to the manual-automatic station and on to the control valve positioner when on automatic position. On manual, this signal is interrupted on a manually adjustable 0-8 ma signal sent to the valve. Check positions on the auto-manual station allow completely "bumpless" transfer between the two positions.

Valve actuator. The cutaway drawing of an electro-hydraulic valve actuator presented here shows how it works. An electro-hydraulic valve positioner is shown in the photo of the Port Credit FCCU.

A third-horsepower electric motor drives a gear-type hydraulic oil pump. The pump takes suction from the valve's oil reservoir, delivers it at 200 psi to a pivoted jet tube. Depending on its deflection, this jet tube delivers oil to either of two receiving orifices that in turn feed one side or the other of the power piston coupled to the valve stem.

Jet tube definition is controlled by the 0-8 ma controller or manual output fed to a coil mounted on the jet pipe in the field of a permanent magnet. A feedback spring from the power cylinder holds the jet tube in position when spring tension due to valve position equals the force developed electrically.

If power to the oil pump motor fails . . . or any type failure occurs in the hydraulic system . . . the valve holds in its last position of control. This locking device is a double-ported, spring-loaded valve in the lines to the power cylinder. Normally held open by pump discharge, it closes on loss of pressure.

Pressure transmitters are similar to the differential pressure unit in that they use a diaphragm that actuates a differential transmitter.

Liquid level transmitters are either differential pressure measuring type or the displacer float type. For the float type, torque tube output of the displacer actuates the differential transformer. ★ ★ ★

Fan law, rated speed testing can give misleading results. So . . .

. . . Use these Equations when Testing Centrifugal Compressors

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WITH THE ADVENT of centrifugal aircraft superchargers and turbojet engines, it became apparent that fan law, rated speed testing for compressors was quite inadequate, and could, in fact, give very misleading results. Analyses showed that the Mach numbers within the compressor, the density ratio through the compressor, and — to a lesser degree — the Reynolds numbers in the compressor passages had to correspond to those for which it was designed. These same principles apply to gas compressor testing, with the additional complication that a much wider variation of gas properties must be considered.

Operating Variables

In successive stages of a multi-stage compressor, clearances, passages and blades become smaller, of course. Each wheel and each stationary passage is designed for a definite flow rate and velocity or Mach number. As the fluid is compressed and heat is added through the machine, the density and the sonic velocity increase. Illustrated in Fig. 1 is the change in these conditions through such a compressor.

As compressor speed varies, the fluid conditions through the machine change considerably. In Fig. 2, density and inlet volume curves are plotted for several speeds to show the marked change in density ratio and ratio of inlet to discharge volume flow at different speeds.

The blading and passages of the compressor are designed for a definite speed, usually at rated or 100 percent speed. At lower speeds there is less compression and the later stages are choked, as shown by the volume ratios in Fig. 2. Testing at lower speeds and "correcting" results up to design speed will give erroneous results because of this choking.

Errors In Fan Law Relationships

The fan laws assume that fluid handled is incompressible and that:

1. Flow varies directly with speed.
2. Head varies directly with the square of speed.

These relations do not account for changes of density and volume ratio and choking or mismatching which must result at off-design speeds.

A comparison between actual test curves and corrected curves obtained by the fan laws is shown in Fig. 3a. Full speed data have been corrected to lower speeds, with results very much at variance with actual test data. Similarly, erroneous results would be obtained by correcting low speed test data to higher speeds as shown in Fig. 3b.

Density Ratio Functions

When air or substitute gases are used to test a gas compressor, it is often necessary to test at speeds other than design to obtain design density ratio through the compressor.

Shown in Fig. 4 is density ratio variation through typical compressors. It varies from only 1.08 in a hydrogen compressor to 7.07 in a propane compressor. To test any of these gas compressors on a different gas, an "Equivalent Speed" would be selected so that density ratio on test would be the same as density ratio with design gas.

Mach Numbers Must Agree With Design

Second important consideration in compressor testing is that Mach numbers in the blading and flow passages must agree with design values. Fig. 5 shows the variation of performance of a single stage compressor with Mach number at the wheel blading inlet. Efficiency, pressure coefficient, and particularly surge range of the compressor stage change markedly at the higher Mach numbers.

Where a substitute gas is used for test, equivalent speed must be selected so that the Mach numbers are identical to actual design. This is most important in testing compressors for heavy gases. For light gases, mechanical considerations usually limit blade speeds to a small fraction of sonic velocity and Mach numbers fall to the left end of the curves on Fig. 5.

Selecting Equivalent Speed

Selection of equivalent test speed for substitute gas is thus governed by both Mach number and density ratio considerations.

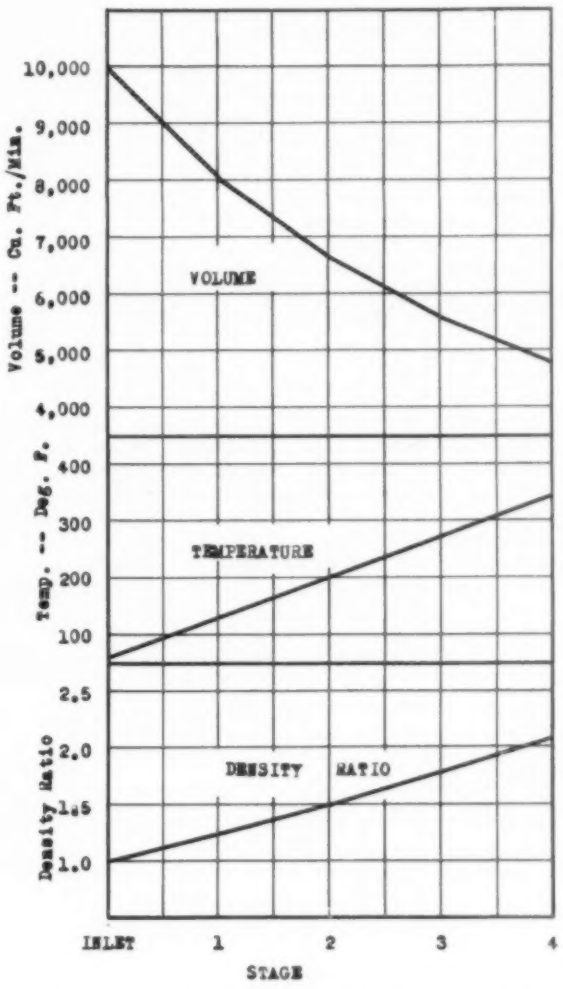


FIG. 1. These curves show how fluid conditions change in each stage of a typical compressor.

Equivalent test speed for a substitute gas at which the design Mach numbers are obtained is determined from the ratio of sonic velocity (see Fig. 7) in the substitute gas to that in design gas. It is usually sufficient to compute this ratio only at inlet conditions. The relation is:

$$N_{eq} = N_d \frac{\sqrt{(kgZRT_1)_s}}{\sqrt{(kgZRT_1)_d}} \quad . \quad . \quad . \quad . \quad (1)$$

Where:

N_{eq} = equivalent test speed
N_d = design speed
k = ratio of specific heats
g = acceleration due to gravity
Z = supercompressibility factor
R = gas constant = $\frac{1544}{\text{mol wgt}}$
T_1 = inlet temperature, deg R
Sub s = substitute gas
Sub d = design gas

Equivalent test speed for a substitute gas at which the design density ratio is obtained is determined from polytropic compression relationships. Computations are made with temperatures and pressures at the compressor inlet and discharge. The relations are:

$$(r_s)^{\frac{1}{n_s}} = \left(\frac{\gamma_2}{\gamma_1}\right)_s = \left(\frac{\gamma_2}{\gamma_1}\right)_d = (r_d)^{\frac{1}{n_d}}$$

$$r_s = (r_d)^{\frac{n_s}{n_d}}$$

$$N_{eq} = N_d \sqrt{\frac{[ZR\frac{n}{n-1}T_1(r^{\frac{n-1}{n}}-1)]_s}{[ZR\frac{n}{n-1}T_1(r^{\frac{n-1}{n}}-1)]_d}} \quad . \quad . \quad (2)$$

Where:

γ_1 = inlet density
γ_2 = discharge density
r = compressor pressure ratio
n = polytropic compression exponent
(other symbols same as for Equation 1)

For perfect dynamic similarity, both Mach number and density ratio with the substitute gas must exactly equal design values. Equivalent speeds calculated by Equations 1 and 2 must, therefore, be identical. In practice this is seldom possible and differences of a few percent between the two computed equivalent speeds are accepted. Referring to Fig. 2, 3, and 5, deviation of three or four percent from rated speed with usually have only a small effect on measured performance.

Table 1 lists a number of typical gas compressors with their design conditions and a possible substitute gas for testing. In these samples, the equivalent test speed has been computed for exact simulation of the density ratio. The errors in Mach number are small and will have a negligible effect on the accuracy of the tests. For lighter design gases, air is the most desirable substitute. For design gases heavier than air, though, a substitute gas of higher density is usually used to achieve good simulation.

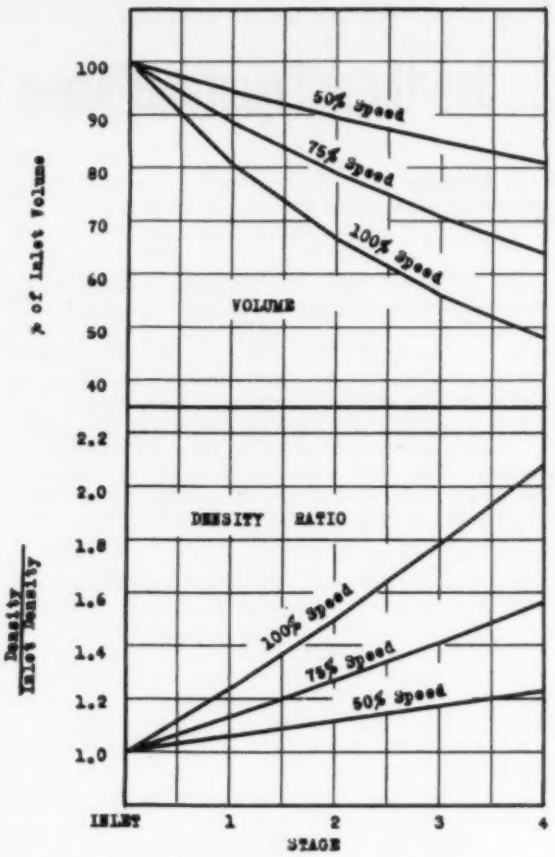


FIG. 2. Density and inlet volume curves show the marked effect of speed on density ratio and ratio of inlet to discharge volume flow.

Translation To Design Conditions

To translate test points to design conditions, the following relations are applied:

$$Q_d = Q_s \frac{N_d}{N_{eq}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Table 1. Typical Test Conditions for Centrifugal Gas Compressors.

Compressor No.	1	2	3	4	5	6	7	8	9
Design gas	H_2 & HC mix.	Coke oven gas	Natural gas	Warm air	HC mix.	HC mix.	HC mix.	HC mix.	Chlorine
Molecular weight	8.51	11.58	17.37	28.97	21.00	31.55	39.80	57.00	70.80
C_p/C_v	1.300	1.395	1.300	1.395	1.200	1.155	1.186	1.120	1.321
Inlet temperature, F	150	95	60	100	110	100	110	35	100
Pressure ratio	1.433	2.018	2.625	3.430	3.730	8.280	4.640	4.720	1.387
Density ratio	1.278	1.574	1.970	2.203	2.592	5.355	3.340	3.720	1.258
Substitute gas	Air	Air	Air	Cool Air	Freon 12	Freon 12	Freon 12	Freon 12	Freon 12
Molecular weight	28.97	28.97	28.97	28.97	120.9	120.9	120.9	120.9	120.9
C_p/C_v	1.395	1.395	1.395	1.395	1.138	1.138	1.138	1.138	1.138
Inlet temperature	70	70	60	40	120	100	100	100	100
Pressure ratio	1.498	2.018	2.905	3.430	3.225	7.840	4.245	4.910	1.310
Density ratio	1.278	1.574	1.970	2.203	2.592	5.355	3.340	3.720	1.258
Equivalent speed, percent of design speed	54.3	61.8	83.6	94.5	37.8	49.4	53.4	75.9	69.9
Error in Mach No.	+3.8%	0	+4%	0	−4.3%	−1.6%	−3.2%	+1.5%	−3.6%

$$H_d = H_s \left(\frac{N_d}{N_s}\right)^2 \quad \ldots\ldots \quad (4)$$

$$\eta_d = \eta_s \quad \ldots\ldots \quad (5)$$

Where:

Q = inlet volume
H = polytropic head
η = polytropic efficiency
(Other symbols same as for Equation 1)

These are valid only for translating data to design speed from a proper equivalent speed where dynamic similarity was achieved, i.e., design density ratio and Mach numbers existed in the compressor. In addition, the relations apply only to polytropic head and efficiency, and are not accurate for isentropic head and efficiency where the ratio of specific heats for substitute gas differs from that of design gas.

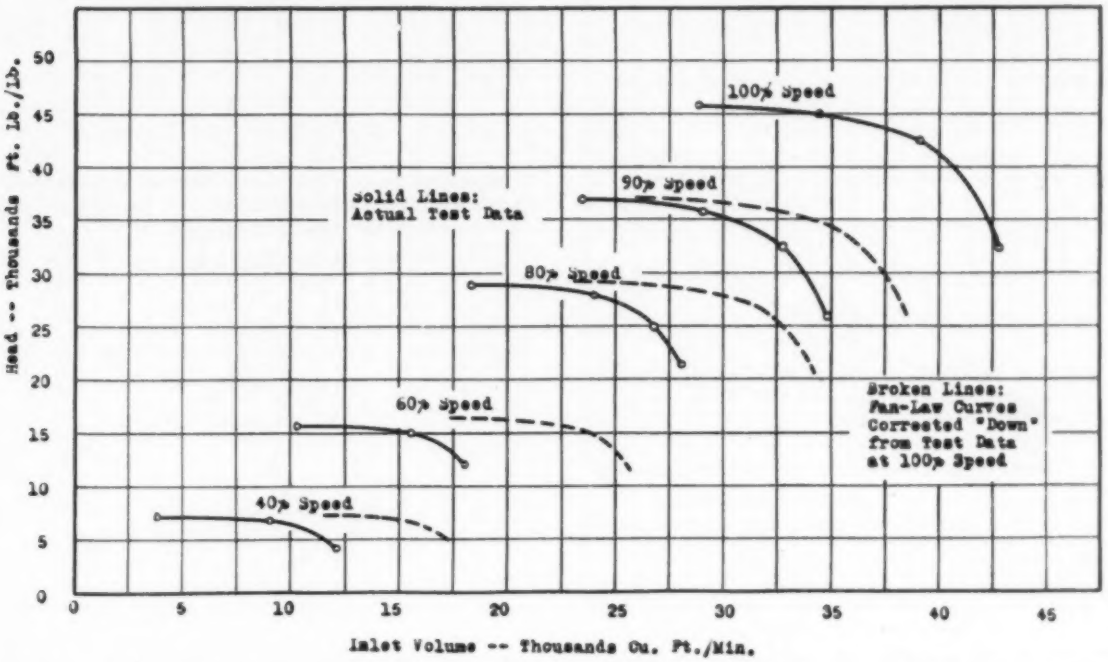
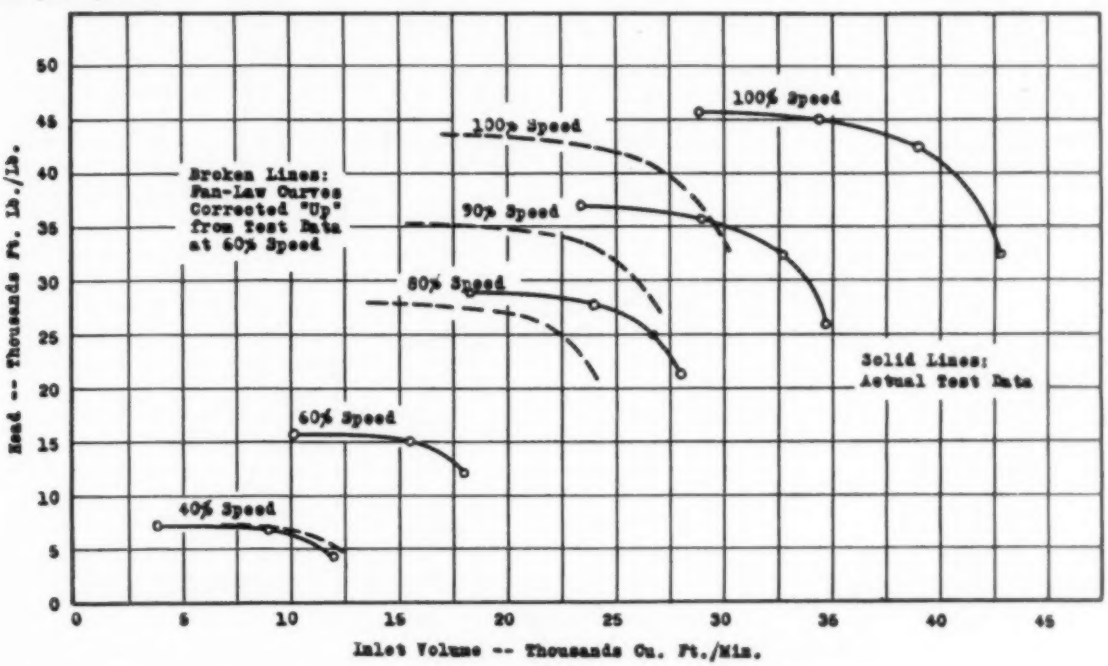


FIG. 3a. (above) Comparison between actual test and corrected curves obtained by fan laws. Full speed data are corrected to lower speeds, with results very much at variance with actual test data. At 60 percent speed, for example, the fan-law curve shows 54 percent more flow at a given head than actually delivered. Data are for a multistage compressor.

FIG. 3b. (below) Actual vs fan-law-corrected curves for shifting multistage machine low speed test data to higher speeds show also erroneous results. Test speed was 60 percent of design; note that the fan-law curve at 100 percent shows much less head and flow than actually delivered.



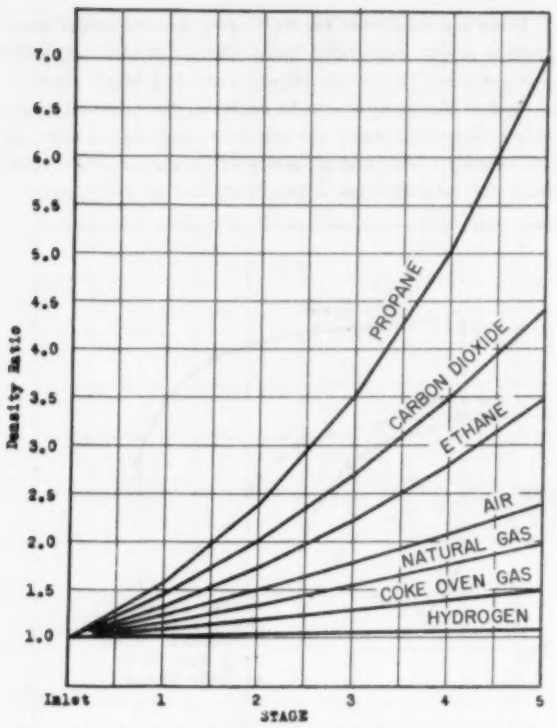


FIG. 4. Variation in density ratio through typical compressors. For each gas the compressor head, or work per pound fluid, is the same and the curves plotted for rated compressor speed.

The polytropic head is defined:

$$H = ZR\frac{n}{n-1}T_1\left(r^{\frac{n-1}{n}}-1\right) \quad . \quad . \quad . \quad (6)$$

Polytropic efficiency is the ratio of the polytropic head to the enthalpy rise in the gas:

$$\eta_p = \frac{ZR\frac{n}{n-1}T_1\left(r^{\frac{n-1}{n}}-1\right)}{C_p\left(T_2-T_1\right)}$$

$$= \frac{ZR\frac{n}{n-1}T_1\left(r^{\frac{n-1}{n}}-1\right)}{ZR\frac{k}{k-1}T_1\left(r^{\frac{n-1}{n}}-1\right)} = \frac{\frac{n}{n-1}}{\frac{k}{k-1}} \quad . \quad . \quad (7)$$

Isentropic head is calculated from the same formula as polytropic head, except that $k = C_p/C_v$, the ratio of specific heats, replaces the polytropic exponent n:

$$H_i = ZR\frac{k}{k-1}T_1\left(r^{\frac{k-1}{k}}-1\right) \quad . \quad . \quad . \quad . \quad (8)$$

Isentropic efficiency is the ratio of isentropic, or ideal enthalpy rise to actual enthalpy rise in the gas:

$$\eta_i = \frac{ZR\frac{k}{k-1}T_1\left(r^{\frac{k-1}{k}}-1\right)}{C_p\left(T_2-T_1\right)}$$

$$= \frac{ZR\frac{k}{k-1}T_1\left(r^{\frac{k-1}{k}}-1\right)}{ZR\frac{k}{k-1}T_1\left(r^{\frac{n-1}{n}}-1\right)} = \frac{\left(r^{\frac{k-1}{k}}-1\right)}{\left(r^{\frac{n-1}{n}}-1\right)} \quad . \quad . \quad (9)$$

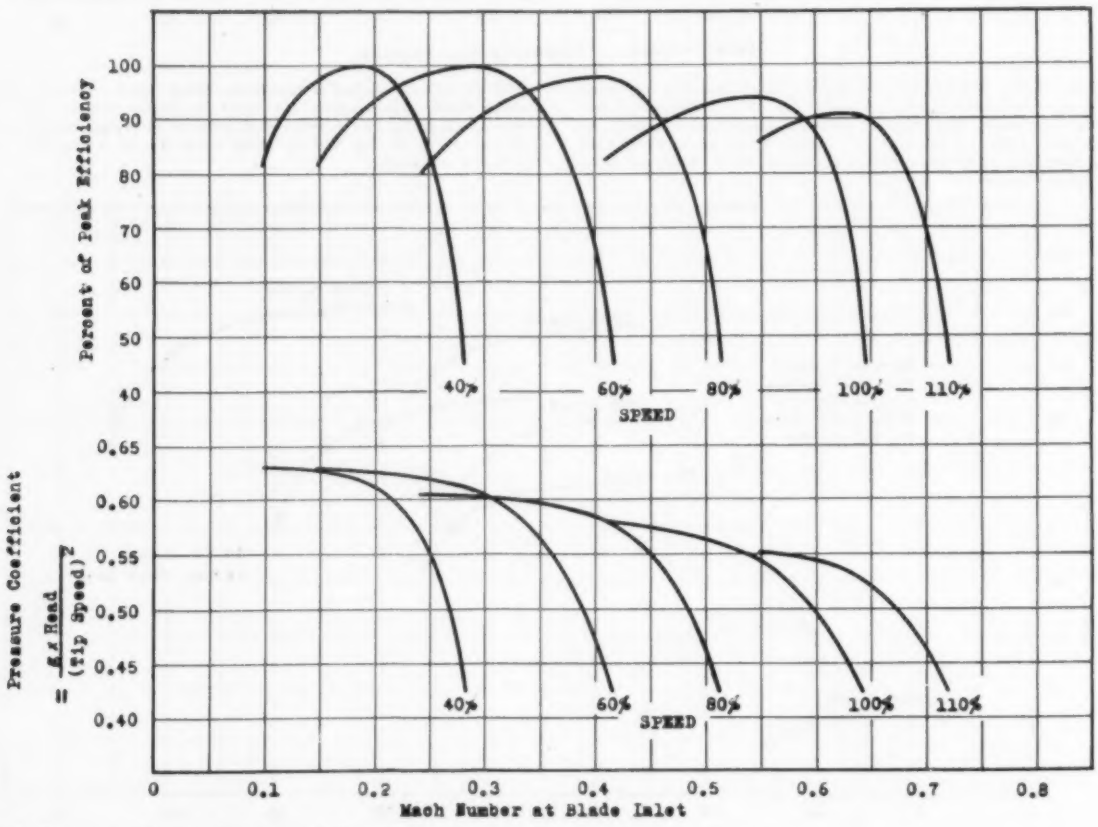


FIG. 5. These curves show performance variation with Mach number in a single stage compressor.

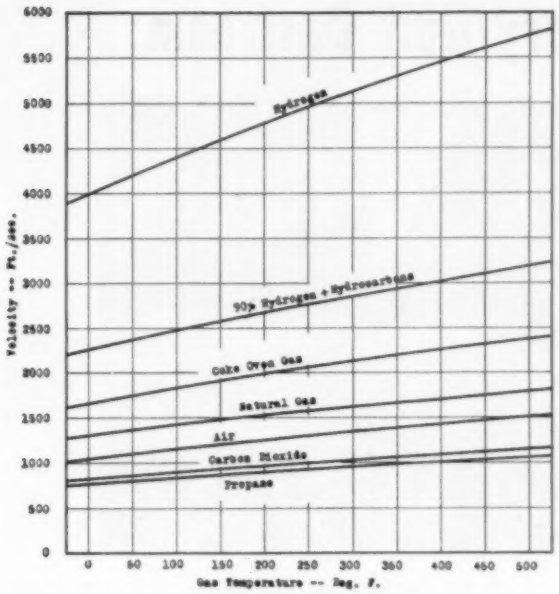


FIG. 6. Sonic velocity of common gases.

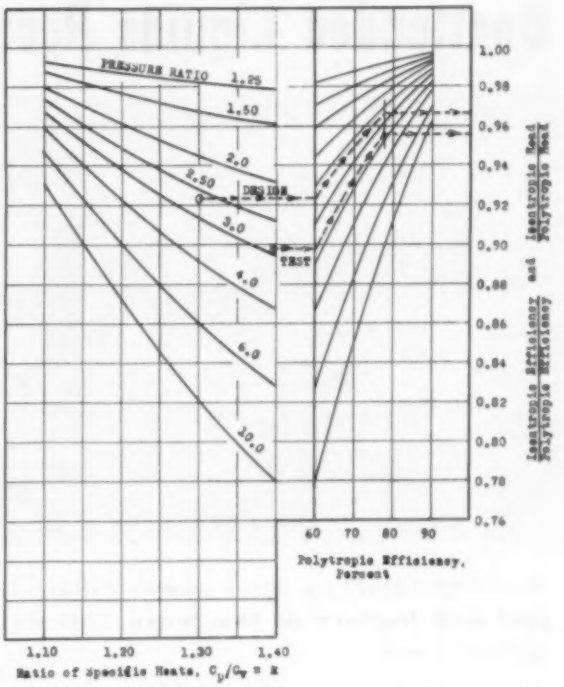


FIG. 7. Variation of isentropic efficiency and head with specific heat ratio. Example shown is for Compressor No. 3, in Table 1.

Where:

H_i = isentropic head
η_i = isentropic efficiency
k = ratio of specific heats, C_p/C_v
T_2 = discharge temperature, deg R
C_p = specific heat at constant pressure
C_v = specific heat at constant volume

(Other symbols same as for preceding equations)

Test Results Obtained

Shown in Fig. 7 is the ratio of isentropic efficiency to polytropic efficiency and isentropic head to polytropic head for various values. The example shown corresponds to the natural gas compressor, column 3 in Table 1. Design k value for this compressor was 1.3, and design pressure ratio 2.625. In the air test, the k value was 1.395 and the pressure ratio was 2.905.

Fig. 8 shows that ratio of isentropic efficiency to polytropic efficiency and isentropic head to polytropic head at design conditions is 0.967, while on the air test it is 0.956. Thus, measured isentropic efficiency and head are 1.1 percent lower in the air test than they will be at design conditions.

Pressure level at which compressor tests are run does not enter the dynamic similarity relations, and performance tests may ordinarily be run at a convenient pressure level. Where the test pressure is greatly different from the design pressure, however, some error will appear because of the difference in Reynolds numbers and friction factors within the compressor.

A high pressure compressor, for example, will show poorer performance at atmospheric pressure than at the design pressure level. This is because friction factors at the test conditions are higher than at design conditions.

Shown in Fig. 8 is the variation of performance in a typical compressor at different Reynolds numbers in the compressor diffuser passages. Where it is not practicable to test such compressors at design pressure level, low pressure test results are corrected by the calculated ratio of friction losses at test pressure to those at design pressure. ★ ★ ★

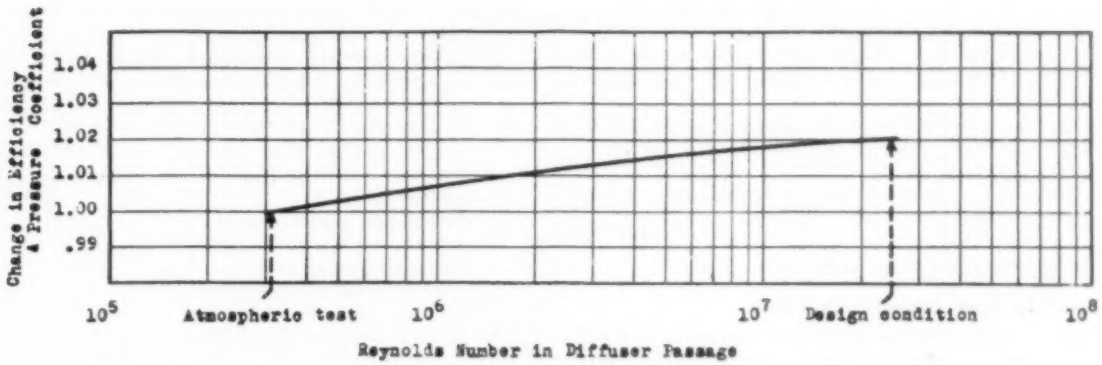
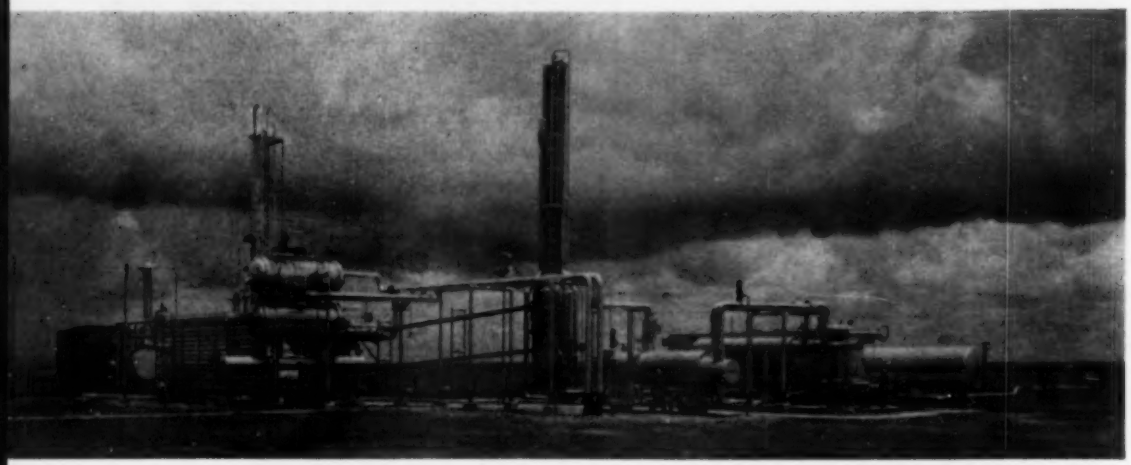


FIG. 8. Effect of Reynolds number on performance.

Unattended Liquids Recovery Unit Onstream



Automatic start-up after power failure is just one feature of the lease unit described here.

William T. Lawler
Sun Oil Company, Dallas, Texas

Problem: Sun Oil Company found it necessary . . . at a small gas processing plant . . . to improve dehydration efficiency while continuing to operate with good liquid extraction efficiency. Additional refrigeration would do this, also would afford opportunity for higher recovery. However, use of conventional methods would have made reasonable payout difficult.

Solution: First, designing for automatic operation with sequential startup and shutdown instrumentation.

Second, use of a minimum number of mechanical devices requiring attention, to reduce operating and maintenance tasks . . . and costs.

Sun Oil Company's West Helen Gohlke recovery plant . . . located near Victoria, Texas . . . was designed to recover stabilized liquids from 10 MMcf per day of combined gas well and oil well gas streams. While available, natural refrigeration from expansion of the gas well gas, with the help of a low-temperature separation and stabilization unit, gave good liquid recovery from both streams.

As reservoir pressures declined, it was necessary to lower the high-pressure gathering system pressure for the weaker wells to flow. Therefore, it became more difficult to consistantly dehydrate the sales gas to a contract maximum allowable water content.

An ammonia absorption type refrigeration unit was selected to provide supplemental refrigeration for these reasons:

1. Ability to perform and adjust automatically to conditions of no load to full load.
2. Fewer mechanical devices requiring maintenance and operating attention are necessary.

Separation and Stabilization Unit

Main gas flow . . . shown by the flow diagram . . . follows the scheme of a conventional lease low-temperature separation unit using glycol injection. Full well stream gas flows into the plant at about 1200 psi. Water is removed. Hydrocarbon liquid and gas are cooled. Liquid flows to a low-pressure cold feed fractionating columns. Stabilizer liquid product is removed from the bottom while lighter components from the top flow into the fuel system.

Low-Pressure Compressor Unit

The casinghead compressor plant consists of two units of conventional design instrumented for non-attended operation. A small atmospheric cooling tower provides cooling for the discharge gas. Aerial cooler sections provide cooling for interstage gas, jacket water and lubricating oil.

Refrigeration Unit

The ammonia refrigeration unit process is a closed cycle continuous process similar to that used in the refrigeration industry for many years. Basically, it is a two-component water and ammonia system, whereby ammonia vaporized in the chiller shell is absorbed in water. The solution is pumped to a higher-pressure distillation column. Condensed column overhead stream — 99 percent plus ammonia — is suitable as refrigerant. A direct-fired process heater provides reboiler heat for the ammonia distillation column. Charge consists of refrigeration grade ammonia, distilled water and sodium chromate corrosion inhibitor. An induced-draft cooling tower provides refrigeration unit cooling.

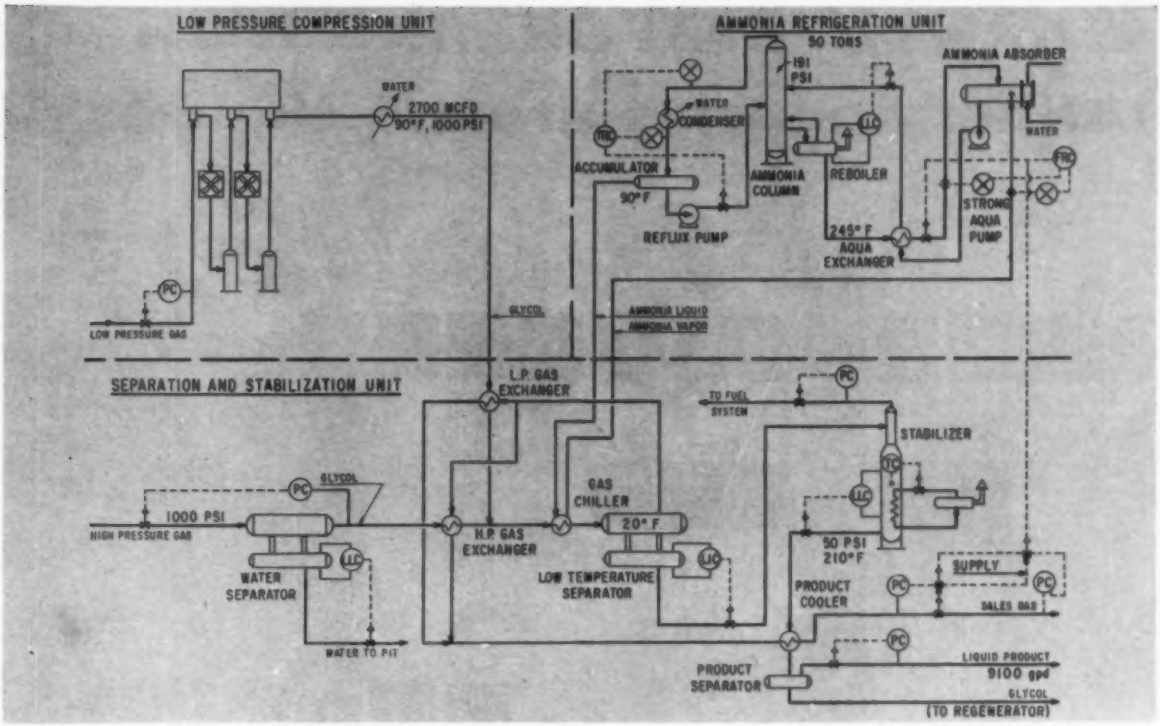
Instrumentation

An attempt was made to install devices that would eliminate all manual steps, either in starting up or shutting down the unit. After extensive trial startups and shutdowns, we feel that this has been accomplished.

Power interruption. It was determined from power interruption records that the most need for a self-starting unit occurs after a short duration power failure. Since most interruptions have been of less than three minute' duration, a five minute time delay relay was incorporated in the main control circuit to the electrical devices. These electrically-powered units are used:

1. Strong aqua pump (spared).
2. Ammonia reflux pump (spared).
3. Ammonia column heater.
4. Cooling tower pump (spared).
5. Cooling tower fan.

As shown on the electrical diagram, a motor-driven reset timer is used as a sequence starter for all electrical units. Motor control circuits are wired into the reset timer con-



Process flow and key instrumentation for the West Helen Gohlke plant.

tacts. The unit can be put onstream or taken off with the switch to the reset timer.

Process heater. The process heater is a skid-mounted self-contained unit wtih these operating and emergency shut-down controls.

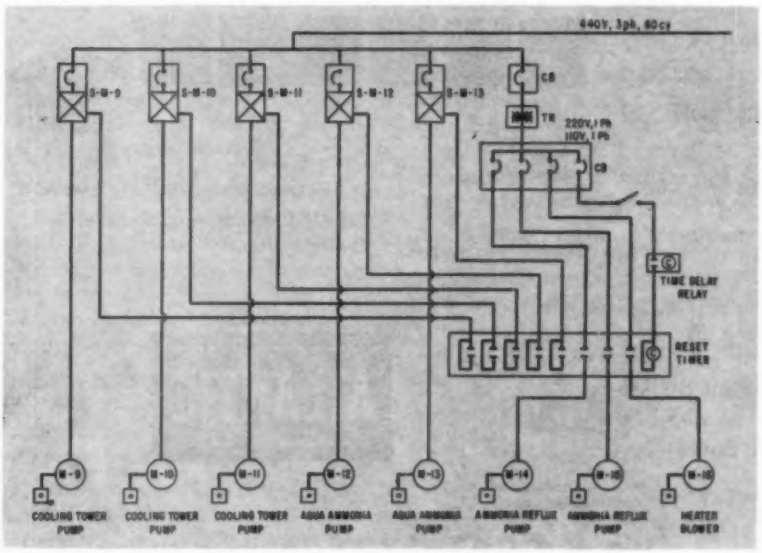
1. Throttling liquid level control.
2. Modulating temperature control.
3. Low liquid level shutdown.
4. High temperature shutdown.
5. Flame out shutdown.
6. High stack temperature shutdown.
7. Low Plenum Chamber pressure shutdown.

Operating Results

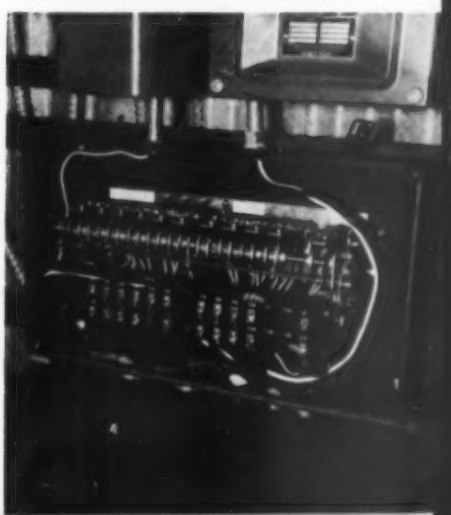
When power failures of up to three minutes occur, tests have shown that all units can be brought onstream automatically: Hence the time delay relay is set for three minutes. Eventually, we hope to run tests to see if longer down-time can be sustained with the units returned to operation smoothly and automatically.

Acknowledgment

Many thanks to my associates — Bob Short, Harvey Evinger, Cullen Tubb and Jim Davidson—for their assistance on preparation of this material. Also, I would like to thank our field personnel and equipment suppliers for their pleasant cooperation.



Single line electrical diagram and the reset timer. The timer is the heart of the automatic re-start system. When power fails, it repositions with all contacts open. When power is restored, contacts are made in desired sequence to re-start motor-driven pumps and fans and to activate electronic controls on the ammonia column's fired reboiler.



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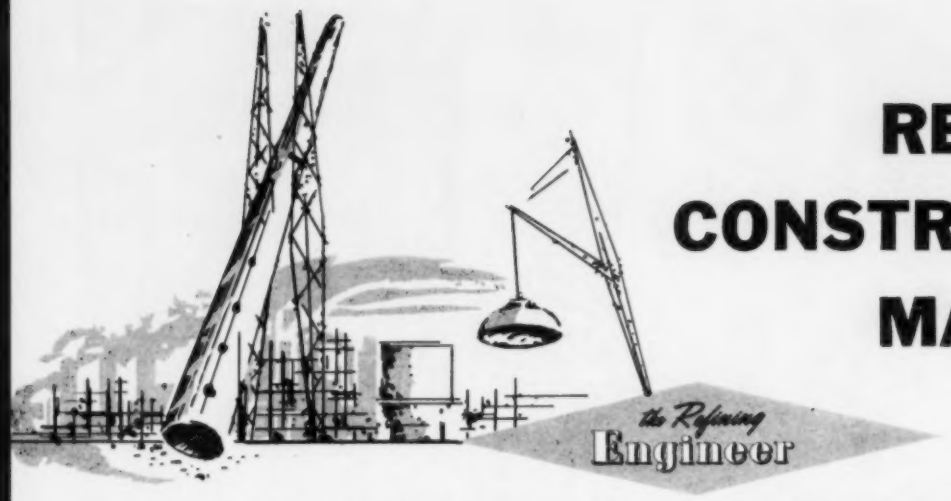

REFINERY CONSTRUCTION MANUAL

PART 3: ECONOMICS STUDIES AND COST ESTIMATES . . .

. . . Examination of Alternate Schemes
. . . Process Investigation
. . . The Definitive Cost Estimate

Henry Martyn Noel
New Canaan, Connecticut

ECONOMIC STUDIES are the first engineering tasks to be done on any proposed new refiinery. Although company management has preliminary data at hand, accurate "official" numbers must be derived as the basis for final decision to build.

Such studies are most commonly done by the refining company's own personnel if it is a larger firm. Smaller refiners and those companies undertaking extremely ambitious projects many times call upon service organizations and engineering-construction contractors to make definitive estimates. One advantage of a company doing its own estimates is that they serve as a good basis on which to evaluate bids for construction contracts.

Engineers propose as the first step a series of alternate processing schemes to satisfy estimated marketing requirements . . . types of products, quality, amounts, based on one or more types of crude oil for processing . . . to be met by the new refinery. One important variable is the amount of flexibility to be provided in the new refinery to permit further expansion and/or to provide for further increases in product quality with minimum alteration to the processes, etc., initially installed.

Economics of various alternates are then compared, based on preliminary or "quickie" cost estimates. Process methods and capacities finally selected from the several "cases" presented become the basis for the definitive estimate. In many instances the basis selected will not be the best from the short range point of view, but will be infinitely superior in the long run. Thus, the company's financial position and management philosophy is an important parameter in making final selection of the basic process scheme.

Process Investigation

Processes never used or fully investigated by the company have to be checked in pilot plants and laboratories to prove them for the products desired from the crude(s) to be processed. Further, these tests are desired by process engineers and estimators to get design data.

The laboratory study is routinely concerned with yields and quality only — assuming the processes being considered are already commercially developed. If a new process is being considered, 2 to 10 years and a million dollars or more may be required to move it from the "buckets and glassware" stage to commercial use.

Laboratory results must show what types of treatment and processing schemes will be feasible for the crude(s) and intermediate refinery products. For example, it is usually desired to make maximum yield of gasoline — especially in North American refineries — of a certain quality consistent with simultaneous production of specified amounts and qualities of kerosine, diesel fuel, various grades of fuel oils, lube oils, asphalts, and certain other specialties. Laboratory studies will show whether one or two-stage crude distillation is best, might indicate that propane deasphalting is necessary to meet certain quality and yield requirements, and so forth.

When dealing with speciality products such as lube oils and certain petrochemicals, laboratories are frequently requested to make large batches for product performance testing and for commercial development purposes. Large batches of motor fuel, heating oil and pitches are frequently needed to test their blending "compatability."

Thus, laboratory programs requiring anywhere from just a few months up to a year or more are needed to provide the process design and estimating engineers with data.

Economic Considerations

The economic items to be ascertained for the various operating alternates include capital investment, process and maintenance costs, crude oil cost and product transportation and terminalling expense.

Labor, utility and reagent costs, adjusted to the new refinery's conditions, can be built up from cost records for existing refineries. Steam, power, and water costs can vary greatly, depending upon local situations — as can labor costs. Also to be considered is whether to purchase steam and power or to generate it in company-owned facilities.

Overhead and capital charges must be determined, the latter depending upon amount of investment required. Certain overhead charges such as state and local taxes might also be a function of investment.

Economics and engineering studies leading up to decision to build major process units such as this 22,500 BPD Houdriformer often consume a year or more in elapsed time. Unit shown above first went on-stream in early 1958, at Tidewater Oil Company's Avon, California, refinery.

Investment figures must be estimated in some detail for several feasible processing schemes, taking into account items such as location, soil bearing conditions, climatology, auxiliary facilities (such as an employee's village), anti-pollution laws, length of crude and product pipeline involved, water supply, depth of waterways, etc.

Local pay scales and labor productivity are vital to the accuracy of detailed investment and operating cost estimates. Many an estimate has gone astray by misjudgment in this area.

Basic materials and equipment costs . . . and erection costs . . . must be up-to-date. Frequent reports from the purchasing department and from trade publications are helpful here, to show cost trends and how they can be applied to extrapolate data from previous construction jobs. Extreme caution is required in scaling up cost from a given-for-a-certain-capacity to actual capacity. Cost scale-up factors can range from 0.3 to 1.0 power, depending on the type of equipment or process involved.

Making a Firm Cost Estimate

Cost tables, showing cost per unit volume throughput for various types of process units and utility installations are fine for preliminary estimating. But, while these tables may be corrected for different capacities and other deviations, they are still much too rough and approximate to use as the basis for a detailed estimate.

A firm cost estimate — *the only kind that should be used in making an appropriation request* — requires that the estimator to take into account all the variables that influence cost.

The Process Information Memorandum is just a starting point. He must know details of the process and utility units; approximate numbers and sizes of furnaces, towers, exchangers, coolers, pumps, instruments for each unit; to what extent of anti-corrosion alloys are needed; and many other factors. These specific data are used in connection with his standards covering electrical work, piping, steelwork, tankage, masonry, insulation and painting. A partial example of a detailed cost estimate is shown in Table 1.

Actual quotations are requested from the purchasing department for items which are: (1) Subject to price fluctuation, (2) needed in large amounts (e.g. piping), or, (3) have to be specially designed (e.g. vessels and reactors). Similar installations on which costs are available will have to be the basis of the estimates, since detailed drawings usually will not be available.

Piping cost estimation requires considerable time, because piping and valving is one of the major items of total refinery cost.

Insulation is estimated as a percentage of figures for piping, heat exchangers, drums, etc.

Structural steelwork may be estimated separately, or as a percentage of the major item it supports. Standards for structural steel vary greatly among oil companies. Some require separate structures for walks and platforms, while others support such items from their towers. In some climates no housing is provided for boilers, compressors, etc., and only light buildings are provided for electrical apparatus.

As much detail as possible on proposed design should be

TABLE 1. PARTIAL SAMPLE OF DETAILED ESTIMATE FOR 6500 BBL PER DAY CRUDE DISTILLATION UNIT.

	Description	Material	Labor
I.	**Heaters**		
	One heater to process 6500 b/sd of 38 gravity crude. Maximum heat absorption rates, external—convection 3,500, radiation 12,000 Btu/sq ft/hr, etc	$53,000	$11,500
II.	**Vessels**		
	One 5′ 6″ x 78′ 0″ x 5/8″ unlined vessel complete with 26 carbon steel bubble trays and 2 drawoff trays, with 8′ skirt, etc	$29,000	$7,500
III.	**Pumps and Motors**		
	One horizonal vertically split process centrifugal pump; 350 gpm at 200 psig discharge, flooded suction cast steel case trimmed for normal corrosion, motor drive	$4,400	$ 300
IV.	**Tubulars**		
	One horizontal shell and tube unit with inhibited admiralty tubes 1″ OD x 14 gage, square pitch NRB tube sheets, steel shell and channel. Approx. surface 4000 sq ft; duty 14 million Btu/hr	$27,000	$ 400
	• • • • • • • • • • • • • • • •		
VIII.	**Foundations and Earthwork**		
	1. **Type**—reinforced concrete		
	2. **Concrete,** cu yd—440		
	3. **Excavation, hand,** cu yd—200 **Excavation, machine,** cu yd—2000		
	4. **Materials**	**Amount**	**Cost**
	Cement, sacks at $0.88/bag	6 cy	$ 5.28
	Reinforcing, lb at $6.75/avt	100 lb	6.75
	Form lumber, BF at $200/mbf	40 BF	8.00
	Sand, cu yd at $2.50/cy	0.5 cy	1.25
	Aggregate, cu yd at $3.00/cy	0.8 cy	2.40
	Total, per cu yd		$23.68
	Totals, for 440 cy 440 cy x $23.68 +		$10,500
	5. **Labor**	**Hours**	**Rate**	**Cost**
	Excavation, hand, 3 hr/cy	600	$ 1.75	$ 1,050
	Excavation, machine	200	10.00	2,000
	Set and strip forms, 4 hr/cy	1760	2.40	4,250
	Place steel, 1 hr/cy	440	2.75	1,200
	Place concrete, 1 hr/cy	440	1.75	800
	Finish concrete, 1 hr/cy	440	2.28	1,000
	Grout	—	—	—
	Totals			$10,300
	6. **Blasting**			$ 1,000
	7. **Piling**			4,700
	Grand Totals..Total Labor			$16,000
	Total Material and Labor			$26,500

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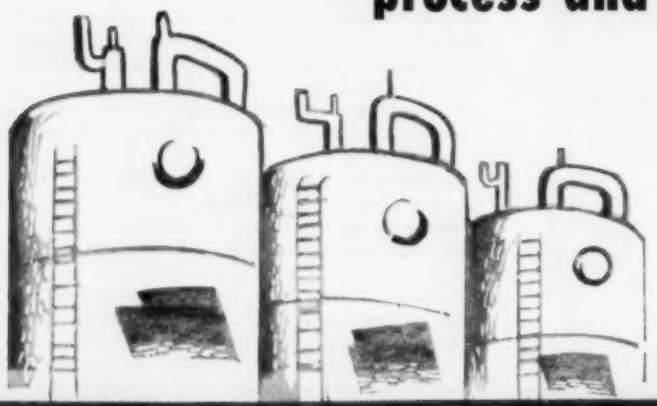
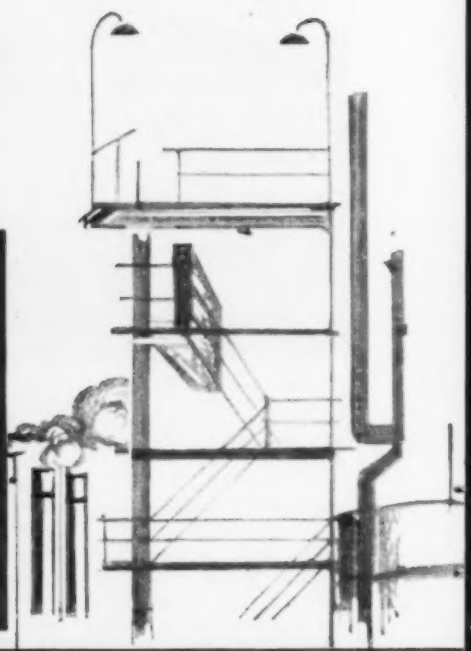
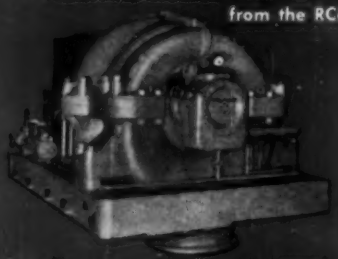
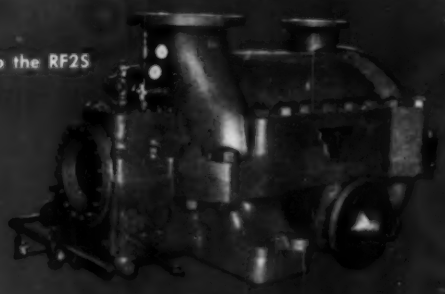




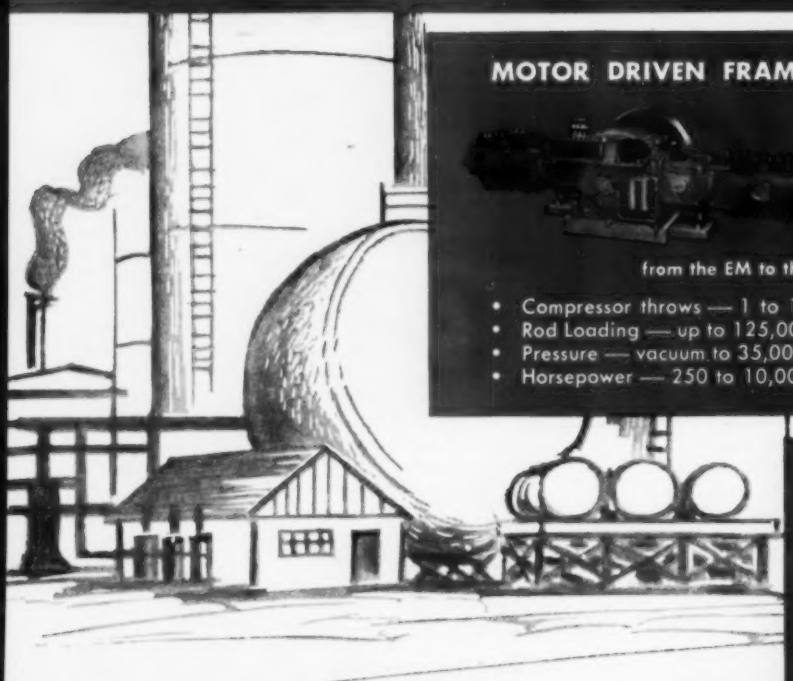
CENTRIFUGALS

from the RC6S to the RF2S

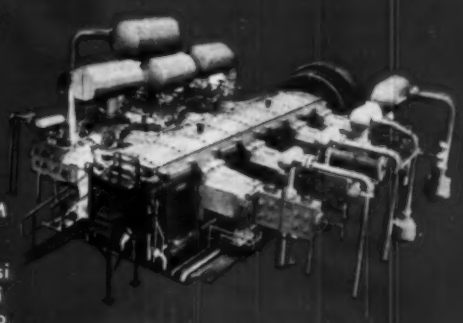




- Pressure — vacuum to 5000 psi
- Horsepower — 1000 to 15,000 hp



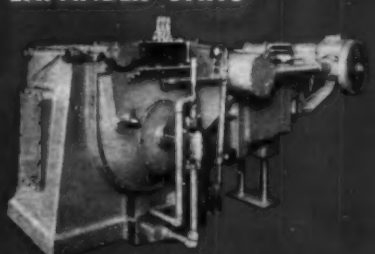
MOTOR DRIVEN FRAMES



from the EM to the LM

- Compressor throws — 1 to 10
- Rod Loading — up to 125,000 psi
- Pressure — vacuum to 35,000 psi
- Horsepower — 250 to 10,000 hp

EXPANDER UNITS



from the JX to the FX

- Pressure — to 3000 psi

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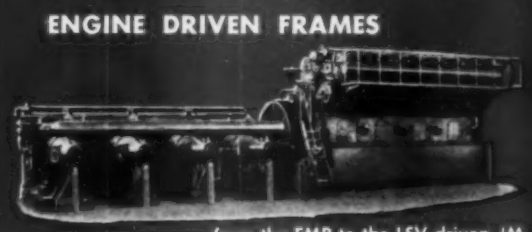
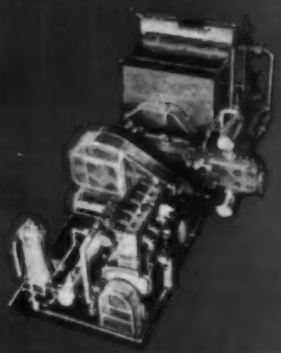
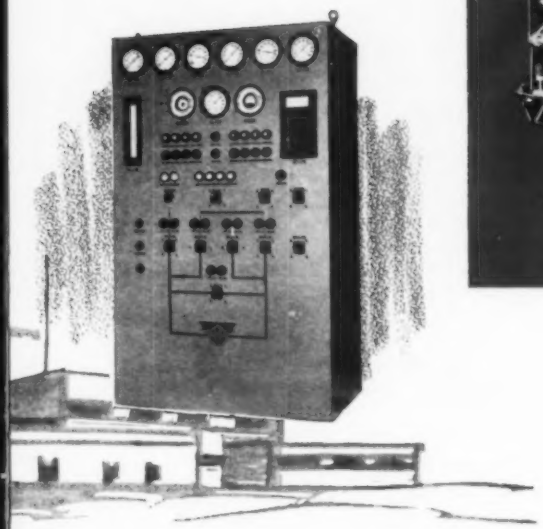
ENGINE DRIVEN FRAMES



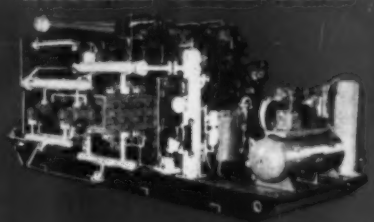


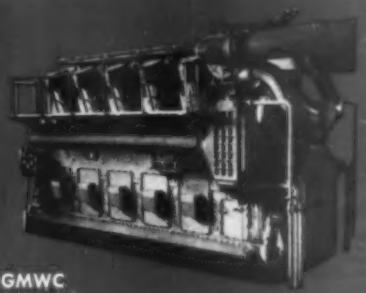
from the FMP to the LSV-driven JM

- Compressor throws — 1 to 10
- Rod loading — up to 125,000 psi
- Pressure — vacuum to 35,000 psi
- Horsepower — 500 to 5000 hp



INTEGRAL ANGLE UNITS





from the GMXD to the GMWC

- Pressure — vacuum to 35,000
- Horsepower — 265 to 3500 hp

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obtained before starting the steelwork estimate, and previous designs of similar units should be studied before making the detailed estimate.

Foundation estimates, such as illustrated in Table 1, should consider climate as affecting precautions against freezing and rain. Simple slabs and footings cost only one-third as much as reinforced concrete structures, and these two types of concrete work must be estimated separately. Soil bearing conditions are quite important—piling, where required, is a high-cost item.

Excavation and form work are estimated for each area, and the question of a central concrete mixing plant for the whole refinery must be considered. The size of concrete pour greatly affects the unit cost of concrete.

For sublet work, it may be desirable to get preliminary quotations from specialized contractors for site clearance, grading, dredging, dock construction, pile driving, residential housing, boiler house, long pipelines, and perhaps the electrical system.

Summary of Detailed Cost Estimate

Included in the summary of detailed estimates, as shown in Table 2 for one small process unit are: (1) Payroll taxes and insurance, (2) field expense, (3) engineering and purchasing, (4) shipping, (5) general overhead, and (6) contingencies incidental to foreign or domestic jobs.

General overhead is imposed by the head office, and is subject to conditions outside of the control of the engineers. Though it is difficult to predict, it is only a very small percentage of the total cost.

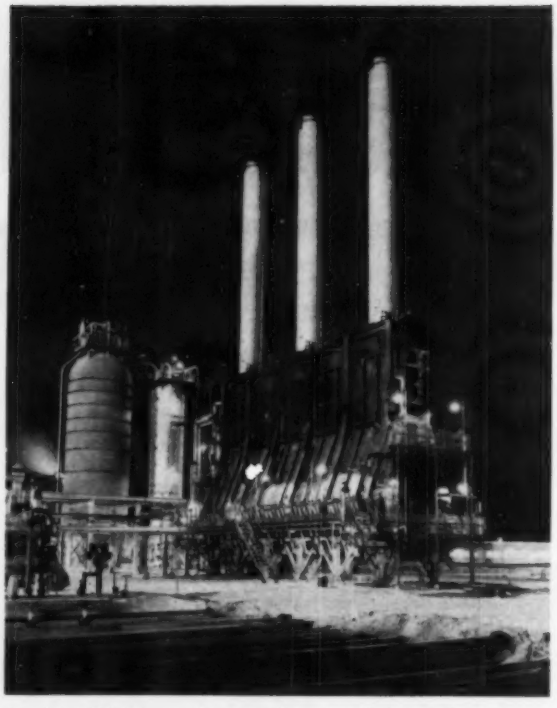
Contingencies include estimating errors and cost items which cannot be foreseen, but which never fail to develop as work proceeds. These unforeseen costs may be several percent of the total cost, including items such as government interference, job accidents not covered by insurance, subcontractors' defaults, and disease.

Contingencies should not include design changes after the estimate is made, but it is difficult to get new appropriations for all minor changes, and some changes invariably creep into the contingency item.

Rough percentages for refineries or units costing less than $10 million are: Material cost 50 percent of total; field labor 20 percent of total; field expense, overhead, engineering and contractor's fee about 20 percent of total, and contingencies, including allowance for estimating errors, about 10 percent of total.

TABLE 2. SAMPLE OF ESTIMATE SUMMARY FOR 6500 BBL PER DAY CRUDE DISTILLATION UNIT.

	Description	Material	Labor	Total
I.	Heaters	$53,000	$11,500	$64,500
II.	Vessels	38,000	6,000	44,000
III.	Pumps and divers	6,200	900	7,100
IV.	Tubulars	57,000	2,700	59,700
V.	Special (inst. aid comp.)	2,600	100	2,700
VI.	Piping	40,000	35,000	75,000
VII.	Structural	18,000	7,000	25,000
VIII.	Foundations and earthwork	10,500	16,000	26,500
IX.	Instruments	25,000	5,000	30,000
X.	Electrical	7,800	7,800	15,600
XI.	Insulation and fireproofing	6,500	14,500	21,000
XII.	Buildings	2,600	800	3,400
XIII.	Painting	800	3,000	3,800
	Sub-totals, materials and labor	$268,000	$110,300	$378,300
XIV.	Payroll taxes and insurance			12,000
XV.	Field costs			50,400
XVI. XVII. XVIII.	Engineering, Purchasing, Accounting and general overhead			29,300
XIX.	Contractor's fee (or profit)			30,000
	Sub-totals, materials, labor and overhead			$500,000
	Contingency, 10%			50,000
	Total estimated job cost			$550,000



American Oil Company's new refinery at Yorktown, Virginia, was designed and located to expand the company's east coast marketing activities at maximum possible realization. In foreground is the heater for feed to the plant's 35,000 BPD crude distillation unit; vessels on left are for cracking unit catalyst storage.

Definitive estimating costs, after project approval and preliminary consideration, account for about 2½ percent of the total engineering manhours.

Cost Estimating Forms

Estimating forms aid thoroughness and accuracy, and are used regularly by most organizations. One form will list — and partially specify — towers, drums, heating furnaces, exchangers, coolers, pumps, compressors, instruments, and other types of equipment purchased complete.

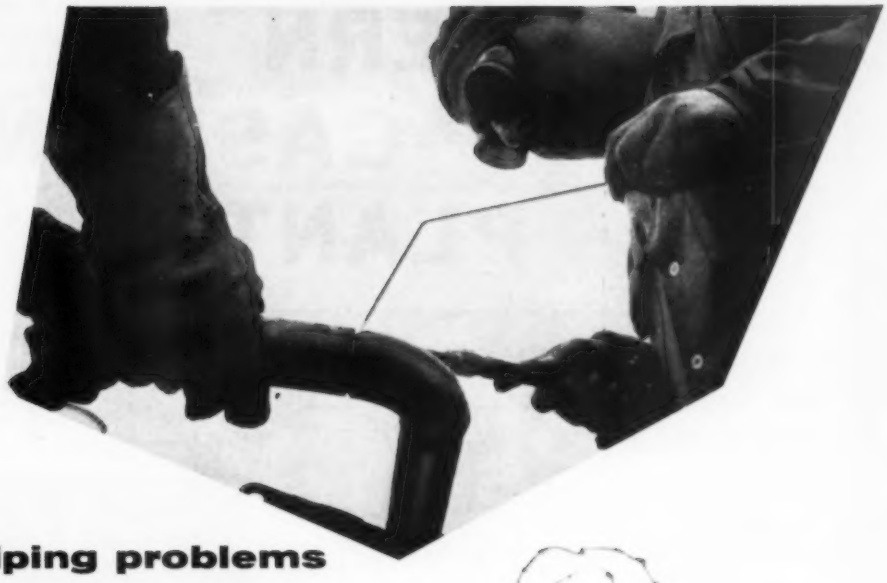
Another form lists pipe and fittings, while another will list structural steel and on another excavation and foundations. Still other forms will list electrical items, insulation, buildings, and painting.

Each item is broken down in some detail and described. Opposite each item are columns for material cost and labor cost. To the totals of all the above categories are added percentages for taxes and insurance, engineering and purchasing, and overhead and contingency.

The sample estimates shown in Tables 1 and 2 might be used for a single distillation unit in a small refinery. They simulate forms used by contractors. They differ from those used in oil companies, in that they are more detailed for concrete work and purposely omit many necessary equipment details.

The estimate for a complete refinery would be the sum of all such detailed estimates, covering offsite facilities such as tankage, pipelines, power house, water supply, etc., as well as process units. Total offsite facilities usually cost from 1.3 to 1.7 times as much as the total process units.

Next Month, ***The Refinery Construction Manual's*** fourth chapter will discuss "Design and Construction Scheduling," showing how good scheduling can save dollars and headaches.



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Dave Vondy
Constructive Engineering Company, New Orleans, Louisiana

Part 4: Abbreviated Plants — Cold Separation, Adsorption, and Crude Oil Absorption

A COMPLETELY integrated plant is not always the most economical scheme for processing natural gas and gas liquids. This situation develops most frequently when small amounts of gas are involved and/or reserves are limited.

There are a number of processing techniques that can be employed under such circumstances. In each, equipment involving lower investment and operating costs is installed in lieu of the more conventional absorption-rectification facilities.

For example, removal of heavy ends to meet end-point requirement in a light distillate cannot be justified if it can be sold as crude petroleum at the same net return that would result from sale as natural gasoline. Or, elaborate absorption equipment can't be justified unless an appreciable return on the additional investment needed can be realized.

These are the alternative processes discussed here: Low temperature separation or adsorption followed by stabilization, and crude oil absorption followed by stripping. Certain combinations of these may prove economically attractive under the proper circumstances.

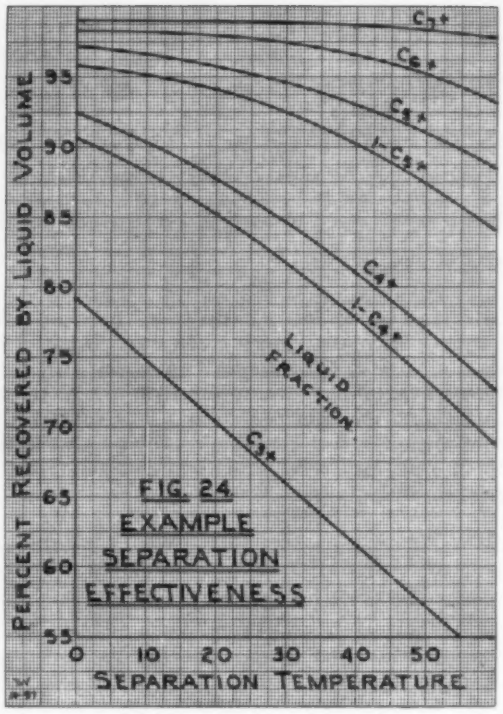


FIG. 24 EXAMPLE SEPARATION EFFECTIVENESS

Cold Separation

Most of the heavy ends in a wet gas can be recovered by separation from gas at reduced temperatures, in lieu of absorption. (Note, however, that some plants have later installed absorption downstream of the low temperature separator, enabled by a change in gas availability or increased products realization.) Effectiveness of this technique is demonstrated in Fig. 24. This chart specifically shows condensation resulting from a crude flash gas compressed to 500 psi, chilled, and passed through a flash separation vessel.

As the data in Fig. 24 indicate, extremely low temperatures may not be necessary or justified unless a high vapor pressure product and/or butanes or propane are to be marketed. Primary separation should, however, be carried out at the lowest possible temperature attainable with existing equipment in order to realize maximum recovery.

Since phase equilibrium is a function of composition,

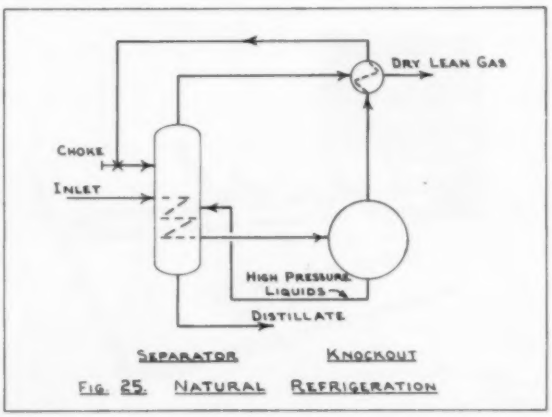


FIG. 25. NATURAL REFRIGERATION

Penex and Platforming of Natural Gasoline

Licensed by: Universal Oil Products Company

DESCRIPTION: The Platforming process for upgrading gasoline components can be used either separately or in combination with the Penex isomerization process to upgrade natural gasoline. Two processing programs are presented here, Platforming alone, and Platforming plus Penex.

The first technique provides for rough separation of the C_5/C_6 fraction as overhead from Platformer feed prefractionator, followed by Platforming of the C_7+. The C_5/C_6 fraction is combined with the C_5+ reformate to become the total C_5+ product.

The second scheme, as shown in the flow diagram, provides for Platforming the C_7+ fractions, as before, and Penex isomerization of the C_5/C_6 fraction. Feed is dehexanized, the overhead C_5/C_6 stream constituting charge to the Penex splitter column and the C_7+ bottoms being sent to Platforming. The C_5/C_6 fraction of the Platformate® also is charged to the Penex splitter.

The combined C_5/C_6 stream is split. Splitter overhead (C_5's) are charged to a deisopentanizer; overhead isopentane is product. The bottoms are charged to the C_5 reactor section. Reactor products are returned to the deisopentanizer, thus normal C_5 is recycled to extinction.

Hexanes from the bottom of the splitter are sent to a deisohexanizer to take higher octane components overhead and C_6 reactor charge as bottoms. Isomerization of the C_6's is a once-through operation.

Both C_6 streams are combined in the final gasoline pool, consisting of up-graded hexanes, isopentane and dehexanized reformate.

PRODUCTS: (Based on feedstock detailed above)

	Composition, Vol. %	RON @ 3ml TEL
Platforming Only		
C_5 Fraction (Virgin)	53.3	95.0
C_6 Fraction (Virgin)	25.4	86.0
C_5+ Reformate (1)	21.3	100.6
Total (93.8% overall yield)	100.0	93.8
Penex and Platforming		
iC_5—Deisopentanizer Overhead	54.1	105.8
iC_4—Deisohexanizer Overhead	8.7	97.7
iC_4—C_6 Penex Effluent	17.6	92.0
C_7+ Reformate (2)	19.6	96.6
Total (93.8% overall yield)	100.0	100.5

(1) 76.4% C_5+ yield of 94.4 RON-clear on C_7+ charge.
(2) 82.6% C_5+ yield of 87.0 RON-clear on C_7+ charge.

*Trademark

TYPICAL FEEDSTOCK: Yield data presented are based on a typical C_5/340°F natural gasoline, composition of which is as follows:

	Vol. % of Feed	Vol. % of Fractions	Research Clear	Oct. No. +3 ml TEL
C_5 Fraction	50.0		76.3	95.0
Isopentane		47.5		
n-Pentane		52.5		
		100.0		
C_6 Fraction	23.8		60.8	86.0
Cyclopentane		2.5		
Dimethylbutanes		5.8		
Methylpentanes		44.8		
n-Hexane		35.5		
C_6 Cyclics		11.4		
		100.0		
C_7+ Fraction (195/336°F)	26.2		55.2	75.0
Paraffins		56		
Naphthenes		38		
Aromatics		6		
		100		
Total C_5+ Gasoline			67.0	88.0

PROCESS ECONOMICS: Basis — 5000 BPD of C_5/340°F Natural Gasoline.

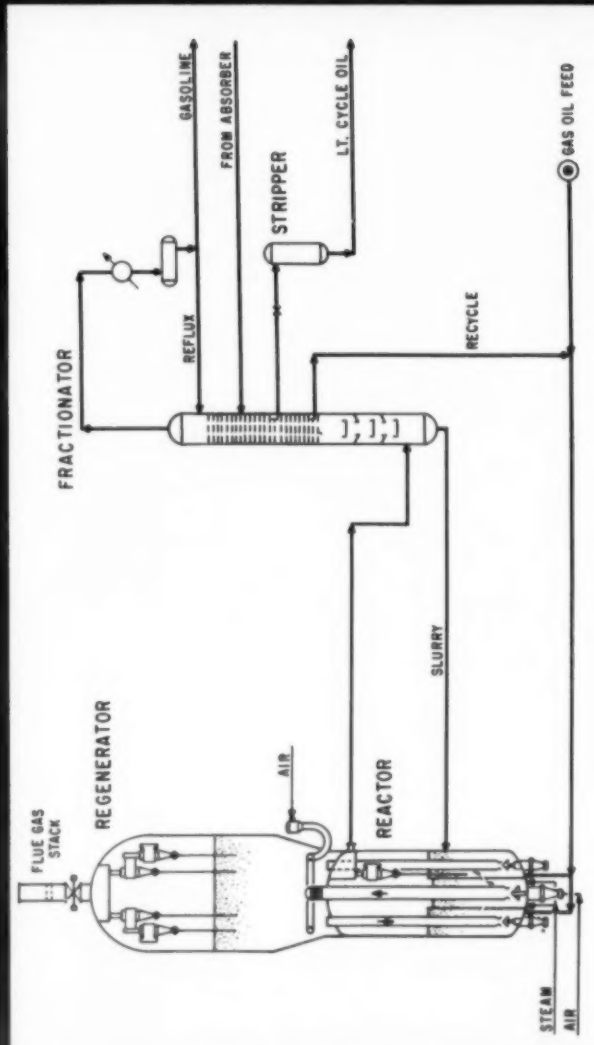
	Platforming	Penex + Platforming
RON + 3 ml TEL		
Total Charge	88.0	88.8
Total C_5+ Product	93.8	100.5
Octane Improvement	5.8	12.5
Value of Improvement	$ .44/Bbl.**	$1.83/Bbl.**
Gross Realization	**$/Day**	**$/Day**
Direct Operating Cost*	530	2,180
Value of Product Lost to Gas (310 B/D both cases)	960	960
Cost of Operation	$1,490	$3,140
Increased Value of Product (4690 B/D both cases)	2,070	8,590
Profit per Day	$580	$5,450
Profit per Year	$212,000	$1,990,000
Erected Cost of Facilities	$830,000	$2,490,000
Payout, Years	3.9 years	1.25 years

*Includes labor and supervision, utilities, catalyst replacement, local taxes, insurance, and maintenance.

**Obtained from price differential of low posted price for Gulf Coast cargoes.

Orthoflow Fluid Catalytic Cracking

Licensed by: The M. W. Kellogg Company



OPERATING CONDITIONS:

Reactor Temperature	885-950 F
Reactor Pressure	14-16 psig
Regenerator Temperature	1050-1100 F
Regenerator Pressure	8-10 psig
Catalyst/Oil Ratio	8-12 C/O
Space Velocity	1.0-3.0 W/Hr./W

Orthoflow Fluid Catalytic Cracking

Licensed by: The M. W. Kellogg Company

DESCRIPTION: The "Orthoflow" fluid catalytic cracking system is designed for production of high octane gasoline at low investment cost.

Feed stocks consist of a wide range of gas oils from atmospheric or vacuum distillation, or from Solvent Decarbonizing, visbreaking or Delayed Coking Products are: High octane gasoline, heating oil, blending stock, diesel oil and fuel oil constituents, light olefins for alkylation or polymerization and fuel gas.

The Orthoflow design provides straight-line flow of catalyst between the vessels, virtually eliminating erosion normally encountered in pipe bends. This principle has been developed in two alternative forms, both in successful commercial operation. In one system the regenerator is located beneath the reactor; in the other it is positioned above the reactor. Both systems have economic applications, the choice depending upon local cost factors. Both realize a unique degree of simplicity of construction, operation and maintenance.

Fresh gas oil feed and recycle from the fractionator enter the base of the reactor through a distribution system. Hot regenerated catalyst flows downward through standpipes, contacts the oil vapors, and is carried up into the reaction zone in sufficient quantity to maintain the reaction temperature. A catalyst bed level is established in the reactor to give the required space velocity. Oil vapors from the cracking reaction are separated from entrained catalyst in internal cyclones and carried to the fractionator.

The spent catalyst stripping zone is positioned centrally within the reactor. Stripped spent catalyst is conveyed upward to the regenerator section with a portion of the regeneration air, which is admitted through the hollow stem of the spent catalyst plug valve. In the regenerator the spent catalyst is contacted with additional air to reduce the carbon content to the desired level. Internal cyclones are used to separate regenerated catalyst from the flue gas stream leaving the top of the regenerator.

In the fractionator, the reactor effluent is separated into gasoline, light gas oil, a recycle stream, and a slurry stream. The recovery and finished gasoline plant consists of absorption and stabilization units to produce a high grade of gasoline. A highly olefinic feed stock suitable for catalytic polymerization or alkylation can also be recovered.

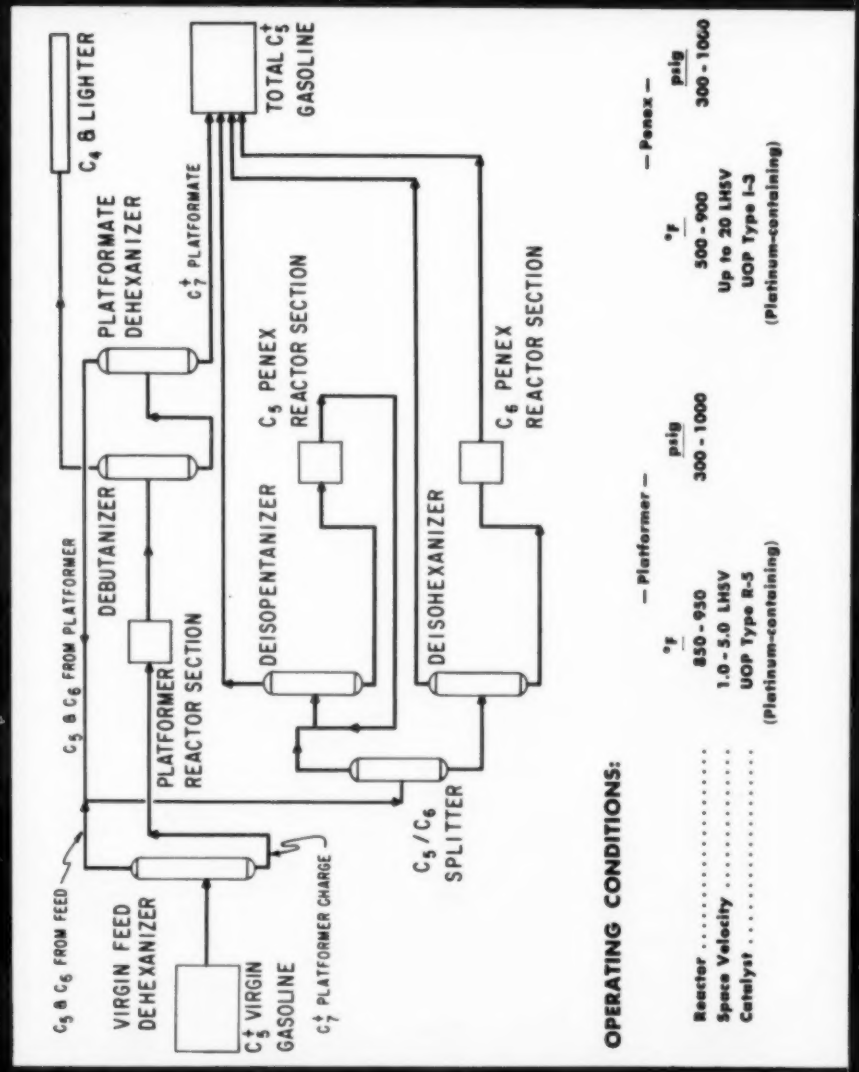
Through the construction of the reactor and the regenerator in a single vessel and the use of straight internal catalyst carrier lines, the Orthoflow represents the simplest design to date. One of the major achievements was the development of plug valves which regulate internal catalyst flow. These valves eliminate need for expansion joints in many instances and are more easily maintained than conventional slide valves. The operating history of Orthoflow units has been remarkably free of erosion difficulties. The rate of erosion of the plugs is considerably less than with slide valves and the plugs inherently compensate for wear without loss of control. Plug valve assemblies are mounted for easy replacement when required.

TYPICAL YIELDS FROM AN ORTHOFLOW F.C.C.U.

Fresh Feed, Mixed Gas Oil, Bbl. per Day	17,600
Gravity, °A.P.I.	28.0
Throughput Ratio	1.5
Conversion, Volume %	70.8
Tail Gas, Weight %	7.8
C_3 to Poly, Weight %	6.9
C_4+ Gasoline, Volume %	58.0
Light Cycle Oil (No. 2 Fuel), Volume %	23.5
Debutanized Gasoline:	
Gasoline, °A.P.I.	58.0
R.V.P., psi	7.0
50 Percent Point, °F	210
End Point, °F	420
C.F.R. R.O.N. Clear	92.0

Penex and Platforming of Natural Gasoline

Licensed by: Universal Oil Products Company



OPERATING CONDITIONS:

	— Platformer — °F	psig	— Penex — °F	psig
Reactor	850 - 930	300 - 1000	500 - 900	300 - 1060
Space Velocity	1.0 - 5.0 LHSV		Up to 20 LHSV	
Catalyst	UOP Type R-5 (Platinum-containing)		UOP Type I-3 (Platinum-containing)	

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separation effect for different gases would, of course, be quite different at any given temperature. In general, though, best separation temperature for stable distillate recovery is below 10 F. (The economic "break point" for use of refrigeration rather than auto-refrigeration usually occurs at a somewhat higher temperature.) The effect of temperature level on overall recovery of distillate usually falls between that which would be determined for normal butane-plus and isopentane-plus, except for gases that contain very little gasoline.

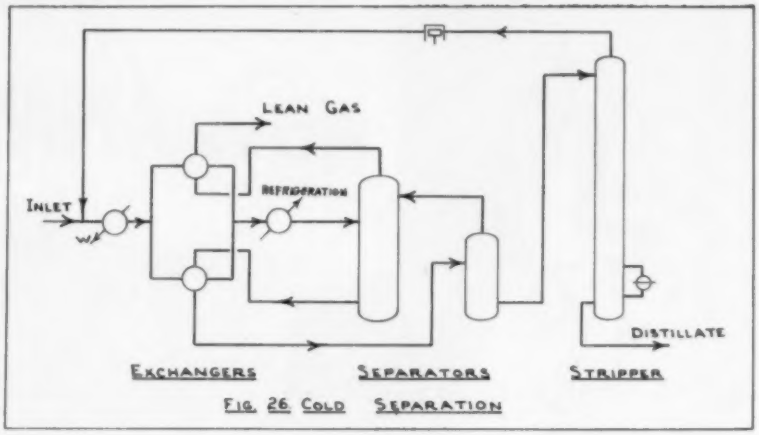

FIG. 26 COLD SEPARATION

Auto-refrigeration. When an appreciable pressure drop is to be taken in a system, it should usually be taken just upstream of the primary separator. The reduction of pressure is accompanied, of course, by reduction of temperature.

Such a processing scheme is shown in Fig. 25. This method is commonly used in production of high pressure gas to obtain maximum distillate recovery and to dehydrate the gas. In this particular flow plan, warm wellstream gas is passed through a coil in the bottom of the separator (liquid section) to melt hydrates which fall from the cold gas section. This gas, slightly chilled, passes through a high-pressure knockout drum where free liquids — including water — are separated. The gas then passes through an expansion valve or choke to obtain the Joule-Thompson effect and into the separator.

Removal of free liquids at the elevated pressure, bypassing them around the cold section of the unit, is important in low-temperature plants. This reduces chilling requirement and takes maximum advantage of available refrigeration in a particular situation.

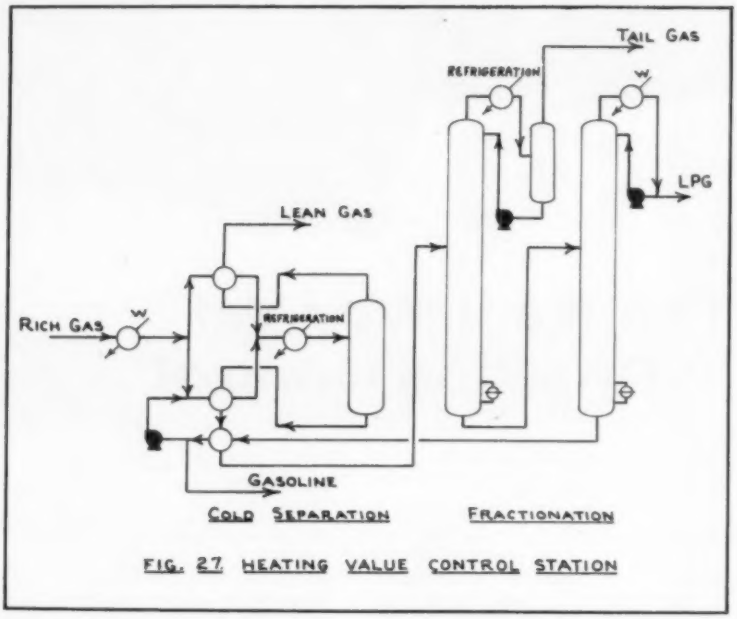

FIG. 27 HEATING VALUE CONTROL STATION

External refrigeration. A plant incorporating external refrigeration, to supplement natural refrigeration, is shown in Fig. 26. Refrigeration effect is recovered from both the gas and the condensed liquid by transfer of heat from the main gas stream. Maximum heat transfer is obtained by parallel exchangers; gas rate can be adjusted between these exchangers to obtain most efficient operation. In this scheme, light fractions are removed from the products in a non-refluxed column, from which the tail gas is recycled to the main gas stream.

When process pumps are not required, it is often practical to design a plant as shown in Fig. 26 with no electric power requirement. Avoiding electric power requirement is particularly important at remote locations where a continuous power supply will probably not be realized.

Heating value control. Shown in Fig. 27 is a plant designed to primarily recover intermediate products leaving sufficient gasoline fractions in the gas to meet a heating value requirement. Recirculation of gasoline significantly increases recovery of LPG. But, an appreciable loss of gasoline occurs.

Control of heating value is obtained by control of recycle rate and separation temperature. Recycle of gasoline without absorption may be the most practical scheme here because the installed cost is relatively low. An absorber can be included to obtain higher recovery with gasoline circulated to the top of the absorber. High propane and ethane recovery is possible in this manner, but special fractionation facilities would be necessary to retain ethane removed from the gas.

Crude Oil Absorption

It is not unusual to find a situation where crude oil absorption can be used to advantage. As shown in Fig. 28, rich gas is contacted by crude oil to recover the distillate fraction. Rich oil is then sent to storage as final product after separation of the solution gas.

Application of this scheme is in situations where distillate recovered from the gas is to be sold with the crude oil and where the crude oil available has a low gasoline content, thus high absorption capacity. Facilities required consist of little more than an oil pump and an absorber. However, duplicate

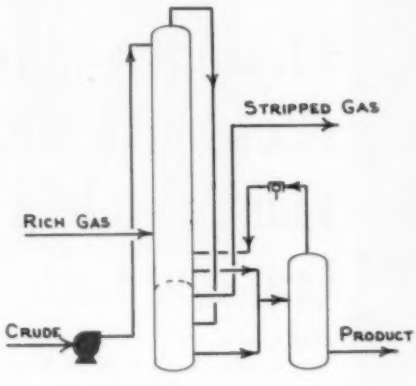

FIG. 28 CRUDE OIL ABSORPTION

crude storage may be necessary for accounting purposes and recycle of flash vapors from the rich oil may be desirable.

At times, it may be feasible to flow product directly to a pipeline without additional pumping. This can be done if the solution gas will not cause excessive load on the line and if this gas can be handled without complication at the pipeline terminal.

Upgrading of a low gravity crude is possible by dilution with distillate in this manner. Resulting shrinkage, the price structure, and acceptance by the purchaser must be examined to establish the feasibility of such an operation. Using dilution, pipeline trouble experienced with a crude having a high viscosity may be avoided or reduced. But, an absorber handling heavy crude may have to be operated at an elevated temperature to function properly. In any event, special attention must be paid to the absorber design to insure that it will operate satisfactorily under adverse conditions.

Adsorption

Adsorption finds application primarily in those situations where the gas to be processed is very lean.

Recovery of distillate by adsorption can be illustrated by a typical plant installed for dehydration of gas. Sufficient distillate will usually be recovered to pay out the installation cost and operating expenses of the dehydration facility. The desiccant not only adsorbs water but also selectively adsorbs heavy ends from the gas.

Illustrated in Fig. 29 is a typical scheme used for adsorption of recoverable distillate from a gas, using a granular material that selectively adsorbs heavy ends in preference to light fractions. Continuous cycles utilizing a single primary vessel have been under development for a number of years and can be expected to come into broader application in the future.

A typical unit designed to operate at pipeline pressure consists of two or more adsorbers, cycled through an adsorption step and then a desorption step. Gas is alternated between the adsorbers while a small stream of desorption gas is taken from the main gas, heated to about 550 F, passed through the bed to be desorbed, and cooled to recover distillate.

Motive power for the desorption gas can be supplied directly by a compressor or a gas pump, or a pressure differential may be created by a valve in the main gas line or a venturi as shown in the drawing. Cycling control is normally handled by a time cycle controller operating valves in the gas lines. Time for a complete cycle is usually about an hour but varies between situations. A short cycle is necessary to reduce to a practical minimum the amount of adsorbent required and, therefore, the size of the beds.

It is possible to locate two units in series to recover two products since heavier material is adsorbed first, but developments along this line have been slow. This is because the second product is readily "contaminated" by the first and the first product will not be free of the second. It may be practical to fractionate the condensed product to increase recovery, and recycle of secondary flash gas and fractionation may both be justified for two products.

Adsorbent requirements dictate that the chemical be in a sturdy pellet form that will not break up in service, even under considerable temperature change. And, the chemical should not lose capacity due to poisoning. Poisoning is usually not a problem if the gas is thoroughly scrubbed ahead of the unit to remove, if necessary, heavy residual and free water. Care should be taken in operation to avoid excessive desorption temperatures which would cause carbon formation.

Silica gel is one of the most practical adsorption chemi-

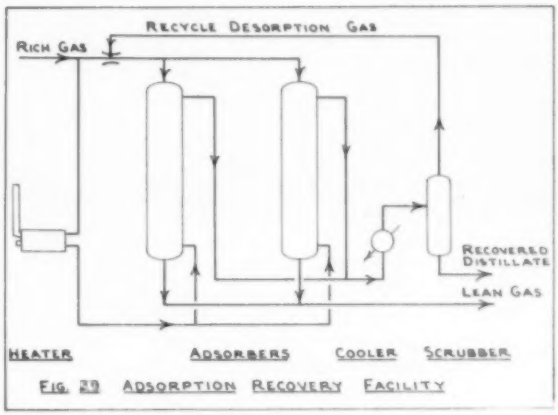

FIG. 29 ADSORPTION RECOVERY FACILITY

cals; it also removes water vapor which is generally an advantage. Activated charcoal shows an advantage in recovery of the lighter hydrocarbons.

Stabilization

Stabilization of wild distillates, particularly those recovered by low temperature separation, has become an important step in the production of gas-condensate wells. By fractionation, an appreciable amount of recoverable liquid normally lost to flash gas can be retained and sold. Also, solution gas is removed at an elevated pressure, making it available to compress for sale.

Increased recovery due to stabilization is usually 4 to 6 bbl per MMcf of stream gas — the more gas involved, the more important stabilization becomes.

Value of stabilization is illustrated by the recovery from a gas-condensate well shown in Fig. 30. The recoveries presented are those obtained with a low pressure stage separator and a nonrefluxed stabilizer. As shown, stabilization is most valuable at low separation temperatures. In-

United Refining Company's cat cracker casts an interesting reflection in the waters of the famous Allegheny River at Warren, Pennsylvania.

UOP Cat Cracker helps United increase gasoline yield up to 50% and reduces lower value middle distillates

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More Than Forty Years Of Leadership In Petroleum Refining Technology

United Improves Flexibility And Economics With Fluid Catalytic Cracking Unit

by H. A. Logan Jr.,
President
United Refining Company
Warren, Pennsylvania

On June 23, 1957, United Refining Company completed 55 years in the refining of petroleum products. As auspicious as this occasion may have been, we did not celebrate in the usual sense. Rather, we concerned ourselves with future plans, in which a 2,500 BPSD UOP Fluid Catalytic Cracking unit, on stream May 5, 1957, has a significant part. Indeed, it is a happy feeling for us at United to know that we are going into our 57th year so well equipped for continuing our tradition of service to our customers by providing top quality petroleum products.

Cat Cracker proves best

Early in 1956, we approached Universal Oil Products Company, licensor of petroleum refining processes, for assistance in planning our modernization program. Because of our particular need, UOP suggested the Fluid Catalytic Cracking unit. But before making a final selection, we organized a thorough and complete study of the problem, including all available alternatives, to determine the process that would both allow us to best serve the needs of our customers with high-quality products, and to do so at reasonable initial investment and operating costs. As a result of this study, we found that the UOP Cat Cracker was the most satisfactory choice for us because the process afforded United a greater flexibility in charge stocks, better quality of products, and lower investment costs. With the addition of the UOP Fluid Catalytic Cracking unit, our refinery is equipped to process a much larger volume of Mid-Continent crude, which will account for the major proportion

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H. A. Logan Jr.

of our light products. Thus, we now have a much broader base of operations, a greater flexibility, and a more favorable economic position than before.

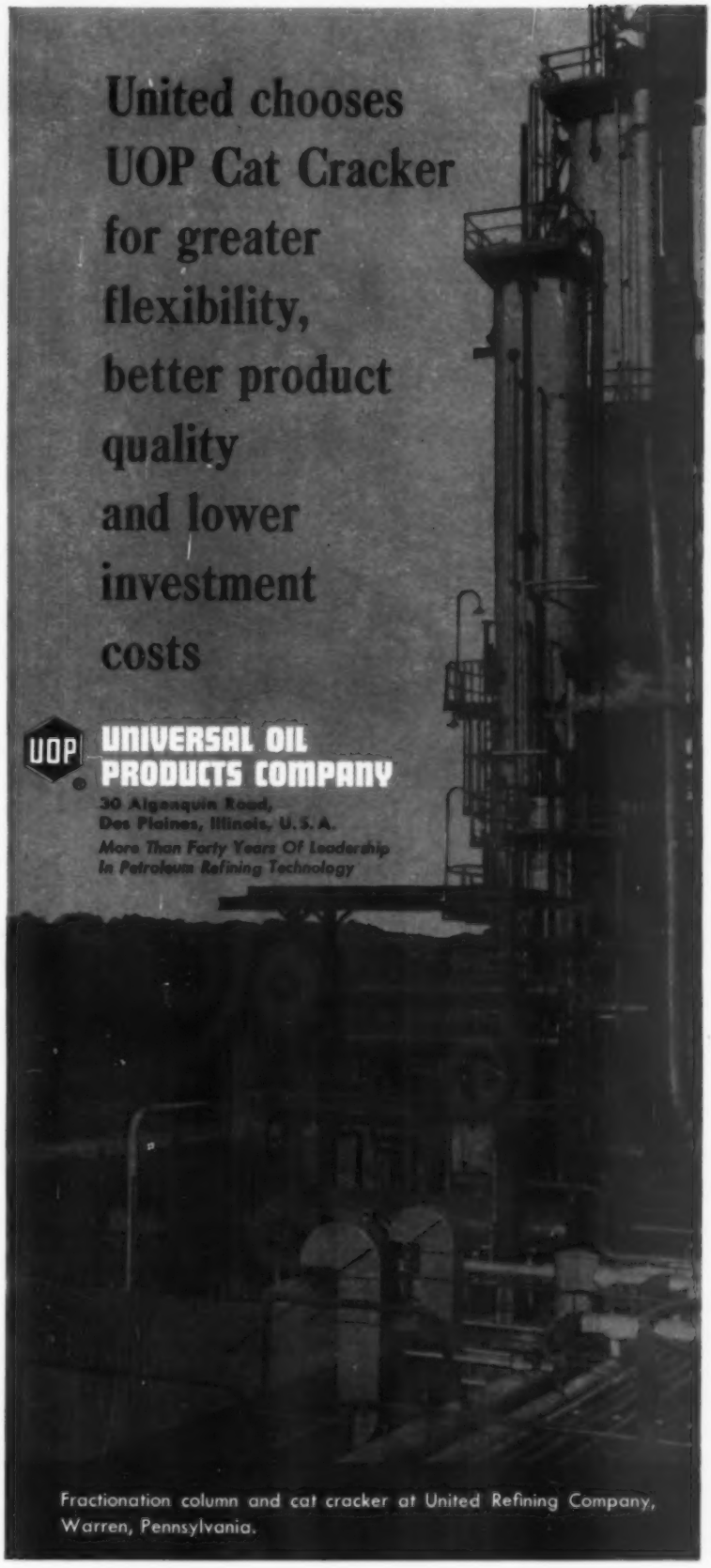
30% to 50% yield increase

As is true with other refiners, we are vitally concerned with yield. Since the UOP Fluid Catalytic Cracking unit was placed on stream, our gasoline yield has increased from 30% to 50% with a corresponding reduction in the production of lower value middle distillates. The cat cracker has provided us with a greatly improved octane potential. Today we are marketing premium and regular gasolines with octane ratings which rank among the highest in the country. As a plus feature, the UOP Fluid Catalytic Cracking unit has given us an improved realization for the middle of the barrel. We are producing one new product from the cat cracker, LPG, that we have not previously marketed.

After several months of operation, I can say that our original assumptions in the selection of the UOP Cat Cracker have been justified. Since our start-up we have consistently operated at design capacity or above, and our yields have been better than UOP's estimates.

For the future . . .

Our 55th anniversary came at a time when, undoubtedly, more is expected from petroleum products than at any other year in our history. Over the years, we have developed a reputation for product quality which we have maintained through the application of the very latest refining technology. At United we use to maximum advantage both the processing know-how of our many years in the refinery business and the technology researched, developed, and made available to us by refinery specialists such as Universal Oil Products Company. In the future we will continue to operate in this tradition.



Fractionation column and cat cracker at United Refining Company, Warren, Pennsylvania.

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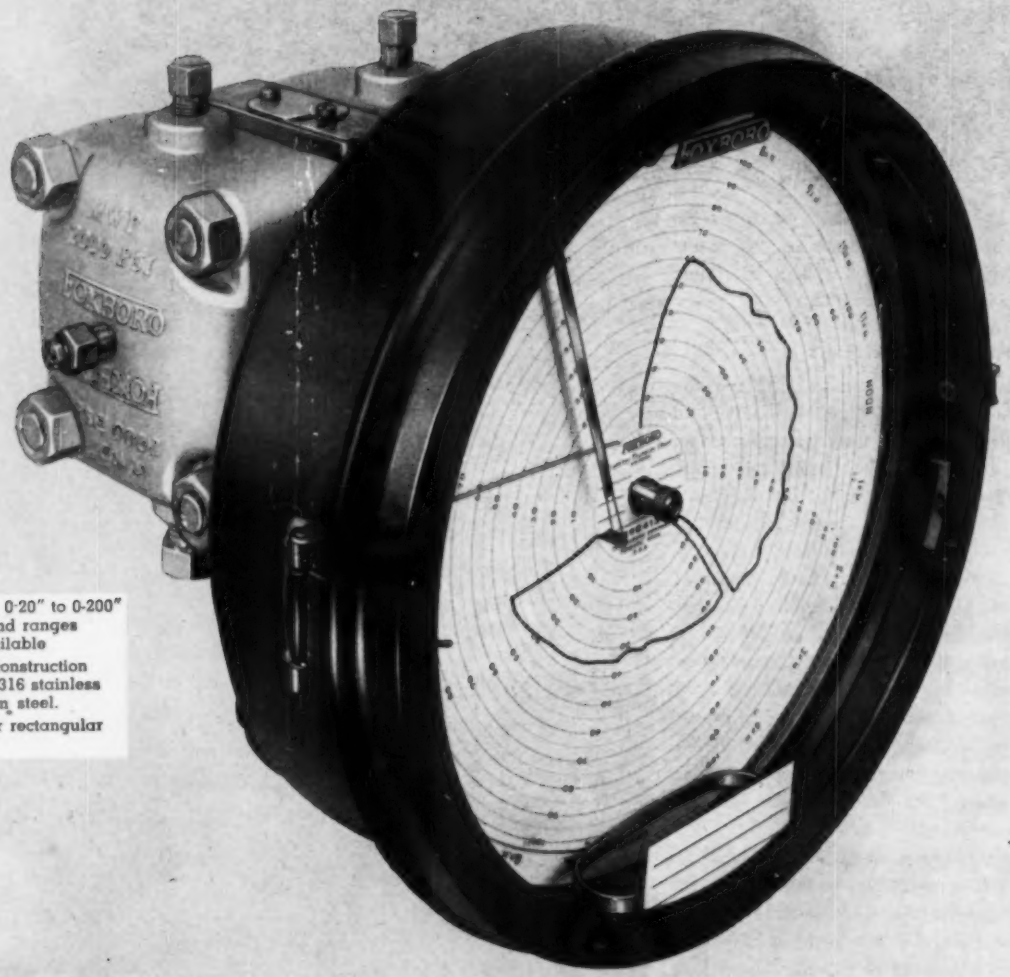

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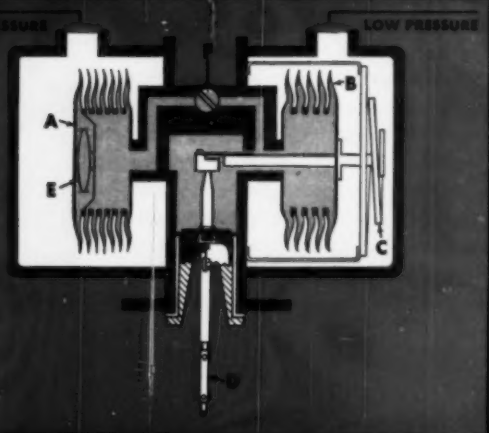
In schematic drawing at right, areas shown in color represent a stable, non-freezing liquid. Any pressure increase in the high pressure chamber compresses Diaphragm Unit A, displacing its liquid and expanding Diaphragm Unit B until force of Range Spring C equals the difference between the forces on Diaphragm Units A and B. Linear motion of Diaphragm Unit B moves inner end of Drive Bar D — outer end moves correspondingly through the bellows-sealed flexure bar, driving pen arm. Built-in Temperature Compensator (E) proportionately adjusts diaphragm capacity as ambient temperature variations affect volume of filling fluid. External damping adjustment is shown at F.



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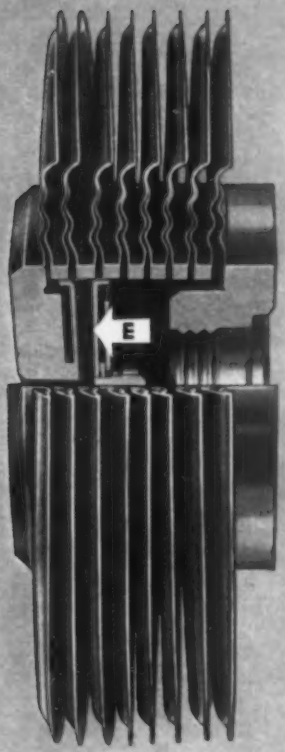

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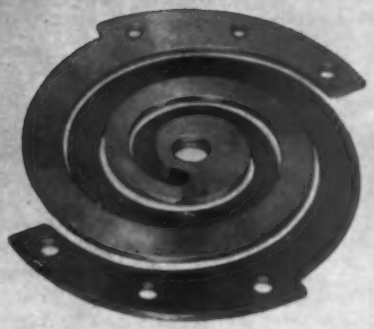

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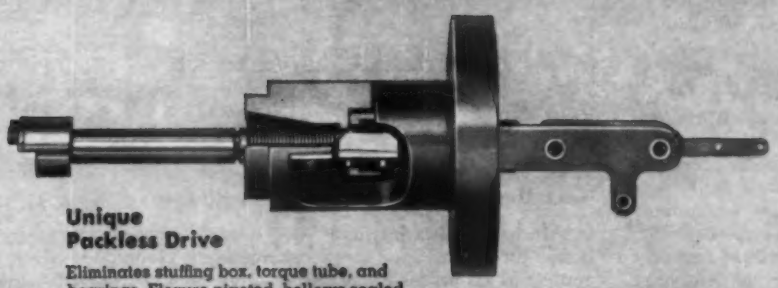

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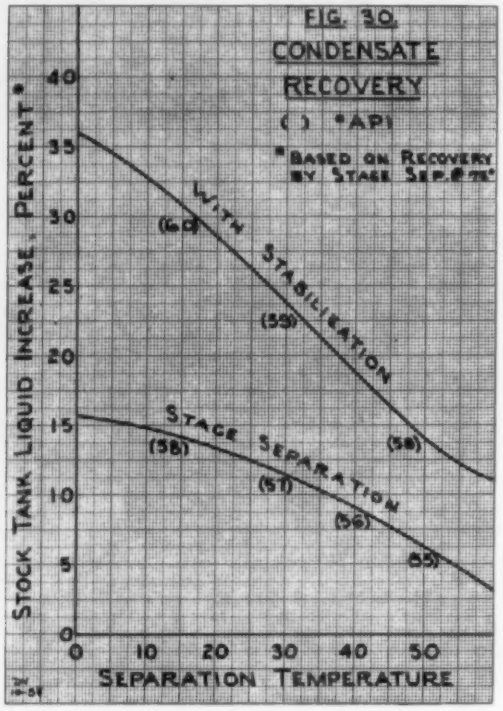

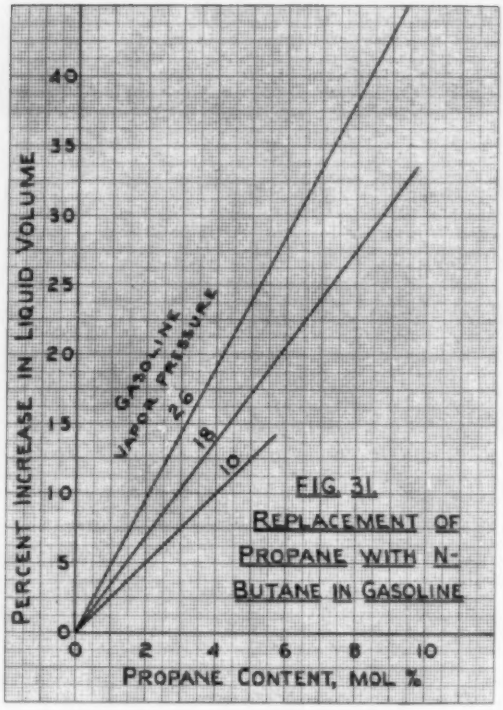

FIG. 31.
REPLACEMENT OF PROPANE WITH N-BUTANE IN GASOLINE

crease in recovery is primarily due to additional retention of intermediate components. This is indicated by the increase in API gravity with increase in recovery.

Fig. 31 shows the importance of replacing low vapor pressure components for lighter components in a liquid product. A larger amount of a lower vapor pressure component will be required for a particular vapor pressure product and, therefore, for one which is to be stored at a particular pressure and temperature. As shown in the plot, if normal butane were substituted for propane in an 18 psi vapor pressure product containing 3 percent propane, the net increase in liquid volume would be approximately 10 percent. Value of this butane in the gasoline would normally be considerably more than if it were sold as a separate product or with propane as LPG.

Crude Oil Stripping

Removal of gasoline from crude oil shows advantage when a high vapor pressure product is available to be blended with this gasoline. Generally, it would not be practical to remove a desired product from crude with elaborate facilities, but simple gas stripping may be feasible.

Stripping is most effective at low pressures, but at low pressure the facilities necessary for recovery of gasoline from stripping gas may be uneconomical. Often the rich gas from the stripper can be introduced into facilities used for other service. Gas may be mixed with that fed to low temperature separation facilities or to an absorber. Or, it may be introduced into a secondary absorber as the reabsorption section of a deethanizer-reabsorber. Various schemes of stripping are used, including stream stripping at a high temperature.

By stripping with butane or propane, it may be possible to produce desired products without additional facilities. Fig 32 shows a scheme of stripping with butane where the crude is heated to a relatively low temperature by hot feed gas (butane). Overhead product flows to plant fractionation facilities to remove ethane and propane from the gasoline.

It would not be possible to introduce these vapors into final fractionation facilities if the heavy end content would raise the gasoline endpoint above limits. But, these vapors may be slightly cooled and the condensed fraction fed into the plant upstream from the point of gasoline endpoint control. In some instances, it may be desirable to heat the rich oil feed downstream from the oil to oil heat exchanger.

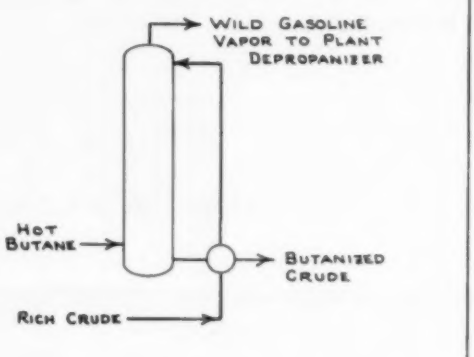

FIG. 32 CRUDE OIL STRIPPING

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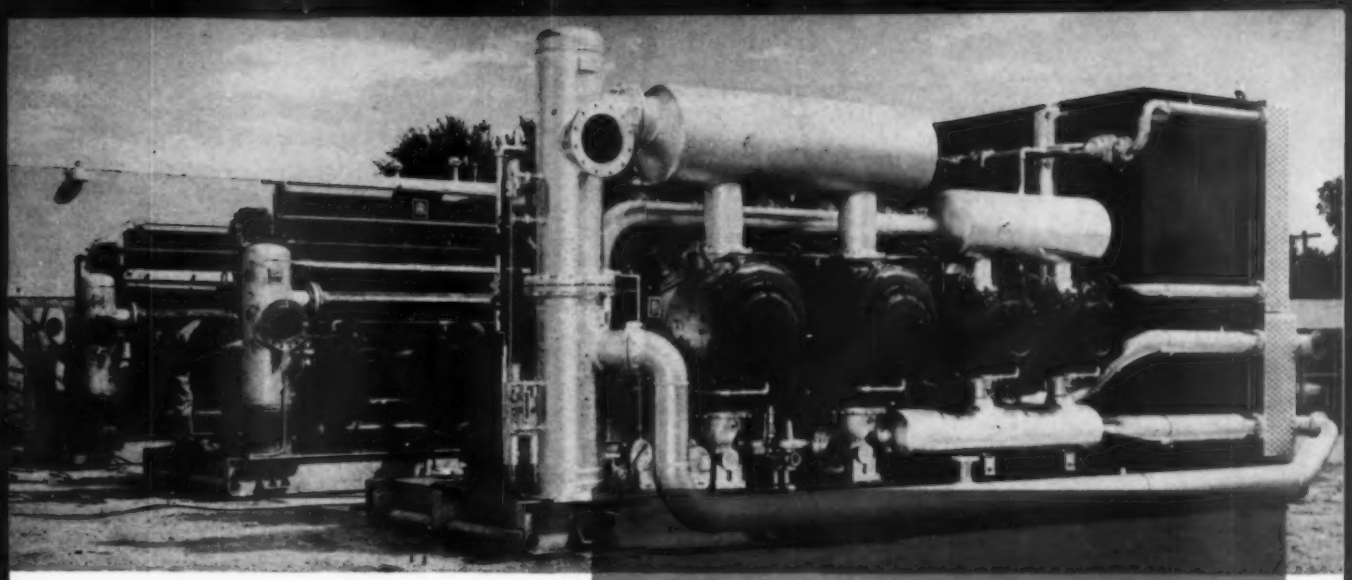
"Mechanical Refrigeration" will discuss vapor compression, absorption, and "deep" refrigeration techniques as applied to gas processing plants.



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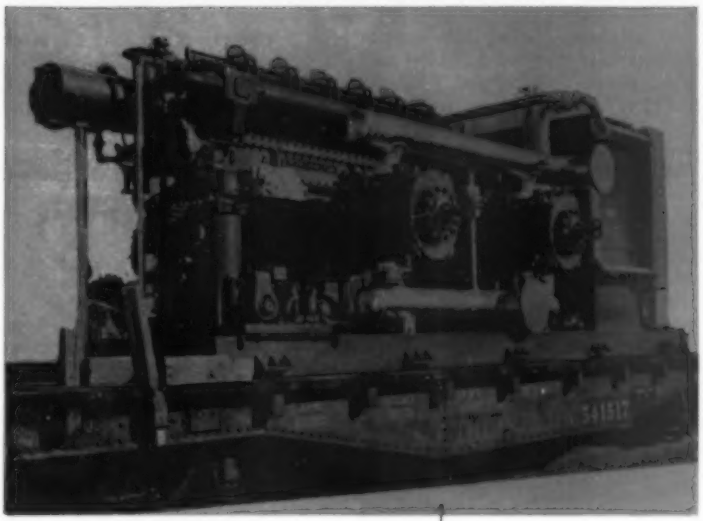

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Here's a fast rundown on . . .

FACTORS IN LUBRICATING GREASE QUALITIES

Dr. C. J. Boner,
Kansas City, Missouri

IN CHOOSING COMPONENTS for greases . . . particularly multipurpose types . . . choice has to be considered in terms of light, medium, and heavy soaps, and low, medium, and high viscosity oils.

When used as thickeners in lubricating greases, soaps of various metals confer different characteristics on the finished product. A soap which will give the most desirable qualities for the lubricant's specific use is therefore chosen. Soaps and non-soaps most commonly used in lubricating grease manufacture are shown in the table. Also included are performance characteristics conferred by the thickeners.

It is quite evident that if one lubricating grease is to be used for a variety of applications . . . as are multipurpose products . . . it should have as satisfactory a rating as possible in each of the qualities listed.

For example, both aluminum and calcium base products have too low a usable temperature to qualify as multifunctional lubricating greases. Sodium base lubricants have the defect of poor water resistance, hence can't be used in all applications.

Barium and lithium base products have better average ratings than do the other lube greases listed. Thus, they predominate in the multipurpose grease field.

Soap content in a lubricating grease depends largely on the product's end use. For example, most products softer than No. 2 NGLI lubricating grease may thin out so much in automotive wheel bearing service that the lubricant may throw out on the brake bands.

Any material stiffer than a No. 2 NLGI grade would be difficult to handle in most dispensing systems. These two factors largely dictate the quantities of soap used in multipurpose lubricating greases. Such proportions can be found in the range of 7 to 15 percent as a rule.

Viscosity of the oil used in multipurpose lubricating greases is a compromise. Since such a lubricant is designed so that it will prove satisfactory in a variety of applications, average or medium viscosity oil is found best. The same general rules hold for the oil in lubricating oils are also true for lubricating fluids. Thus, for high speeds a a low viscosity oil is best and for low speeds a high viscosity oil is preferable. It is evident that a multipurpose grease might be used in either type of application and therefore an oil intermediate in viscosity will more nearly satisfy both conditions.

Another consideration influencing choice of an oil of a certain viscosity is that one roller bearing company recommends a minimum viscosity of 75 SUS at 210 F for wheel bearing lubricating greases. Some suppliers, knowing that their multipurpose lubricating grease will be used for such applications, use this as a basis for oil used in the subject lubricant. It will be found that most lubricating greases of this type contain oils of a viscosity range of 300 to 800 SUS at 100 F.

Certain characteristics of lubricating oils largely determine ease of dispensability or pumpability at low temperatures. Thus, oils of high viscosity and low VI, which generally also have high pour points, give products which are difficult to pump at temperatures of freezing or even higher. Conversely, low viscosity, high VI and low pour point oils tend to permit production of lubricating greases which can be dispensed even at zero.

An extreme instance of the latter point is illustrated by products meeting MIL-G-10924A specification, which is used for lubrication of artillery and automotive equipment by the armed forces. Since it is expected that a vehicle may be required to operate in varying climatic conditions without a change of the lubricating grease, the lubricant must function over a wide temperature range. This characteristic is obtained by using oils with viscosities of 100 SUS at 100 F or less.

Several years' operation with lubricating greases corresponding to this specification has demonstrated that in well made products very low viscosity oils will function satisfactorily over a temperature range of −65 to +150 F.

* * *

TABLE NO. 1. Performance Characteristics of Different Types of Lubricating Greases. Based on average lubricating greases in trade.

	Maximum continuous usable temp °F[1]	Pumpability at 32 F	Low temp starting torque	Water resistance	Worked stability	Service life
SOAP BASE						
Aluminum	175	Fair	Medium	Fair	Poor	Short
Barium	350	Fair	Medium	Good	Good	Moderate to long
Calcium	175	Good or Fair	Medium to Low	Good	Fair	Moderate
Calcium Complex	250	Fair	Medium to Low	Good	Fair	Moderate
Lithium	300	Good or Fair	Medium to Low	Good	Excellent to Fair	Moderate to Long
Sodium	250	Good to Poor	High to Low	Poor	Exhellent to Poor	Moderate to Long
Sodium-Calcium	250	Good to Fair	Medium to Low	Fair to Poor	Excellent to Poor	Moderate to Long
NONSOAP BASE						
Modified Bentonite	250	Good to Fair	Medium to Low	Good to Fair	Poor	Moderate to Short
Fine Silica	250[2]	Good to Fair	Mediun to Low	Good to Fair	Poor	Moderate
Organic Compounds	300[2]	Good to Fair	Medium to Low	Good	Good	Moderate to Long

(1) When certain synthetic lubricating fluids replace mineral oils, Maximum Continuous Usable Temperature may be as high as 400 F for some compositions containing organic thickeners and fine silicas.
(2) Values are influenced by viscosity of the oil in the lubricant. This tabulation presumes an oil of about 20 SAE grade.

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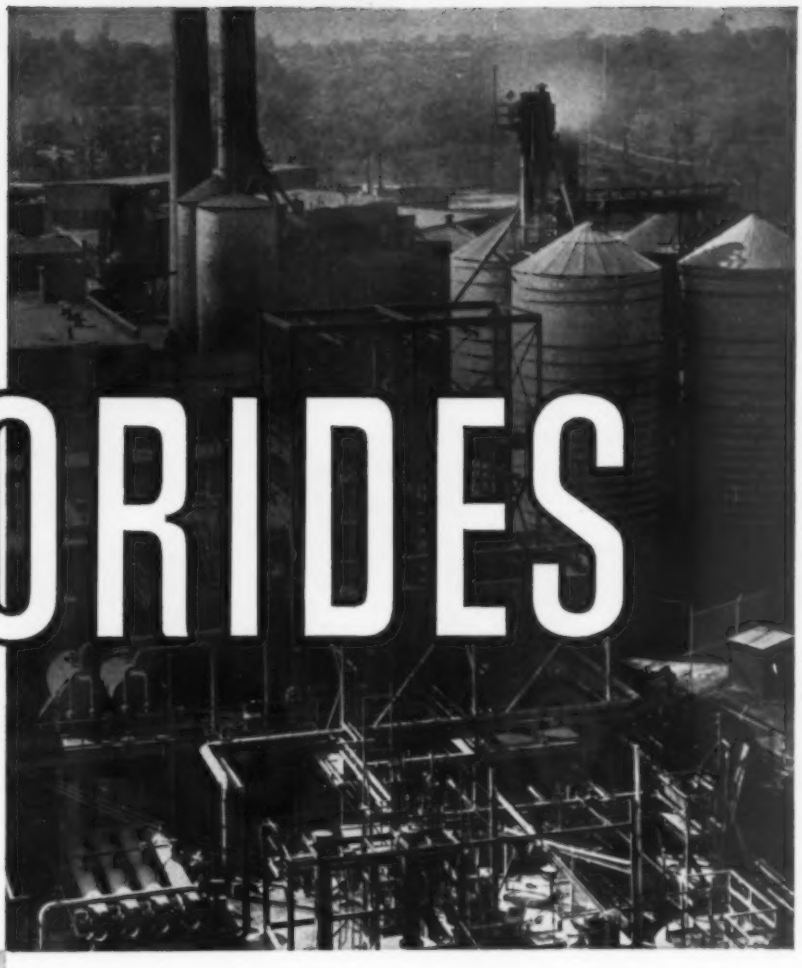

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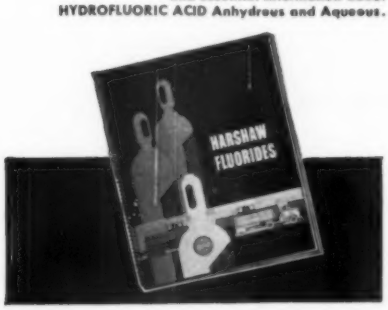

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Hydrofluoric Acid Aqueous
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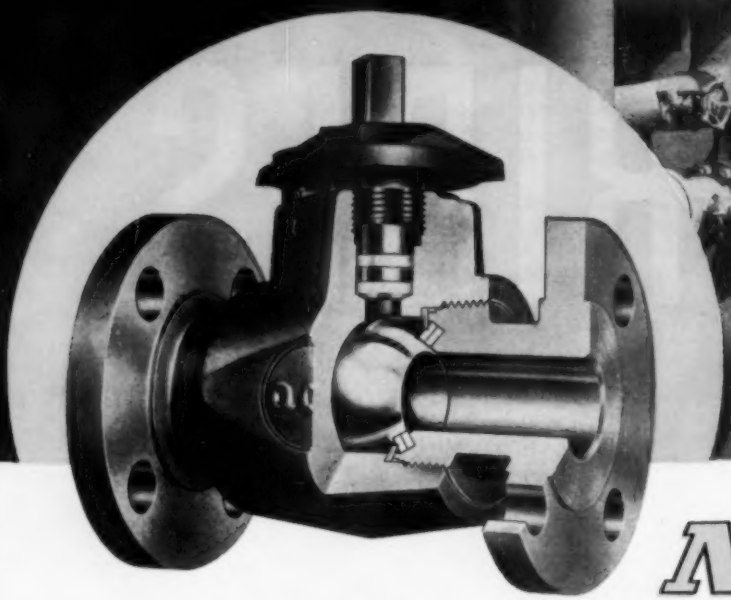

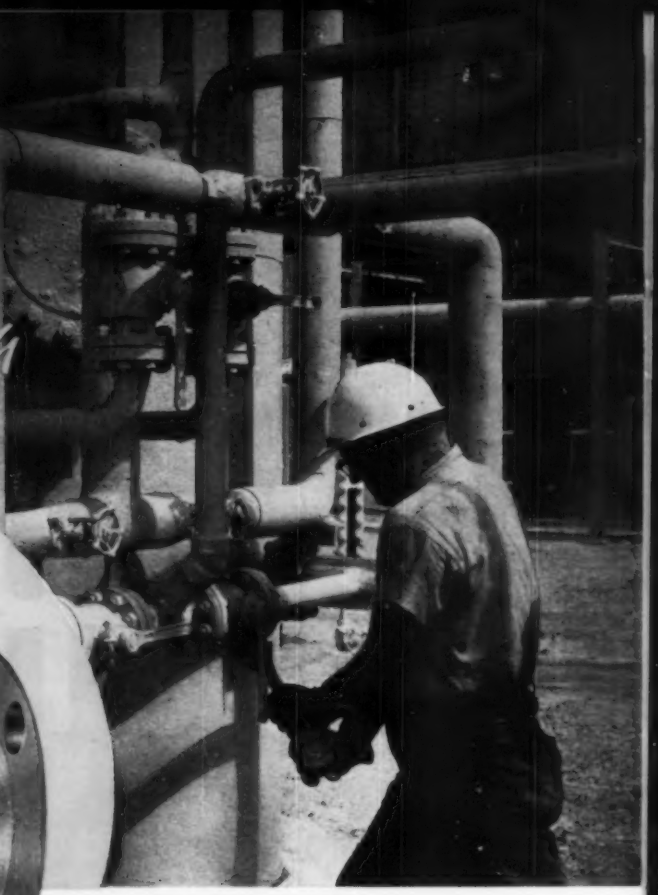

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Refining Books to Read

Successful Process Plant Practices, *edited by Robert L. Davidson, published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York. Pages 302. Price $10.*

Essentially a how-to reference manual of successful process plant practices, it puts at your fingertips practical methods and devices to deal with problems in managing, scheduling, operating, maintaining and repairing in all process industries. It includes over 270 drawings and photos illustrating points to help you find the right answers to problems with minimum of time and trouble.

Fundamentals of Chemical Engineering Operations, *by Maurice G. Larian, published by Prentice-Hall, Inc., 70 5th Avenue, New York 11, New York. Pages 644. Price $10.50.*

This book has its greatest emphasis placed on the thermodynamic viewpoint in treating unit operations. It is written from a somewhat practical viewpoint and includes references to engineering economics, illustrated by appropriate examples. The author has held the descriptive material on equipment to a minimum.

Advances in Petroleum Chemistry and Refining, *Vol. I, by Kenneth A. Kobe and John J. McKetta, Jr., published by Interscience Publishers, Inc., 250 5th Avenue, New York 1, New York. Pages 641. Price $13.50.*

This is the first in a series on the petroleum and petrochemicals industry. Advances made by this industry are recorded in this first volume. Here is a book that ties the research scientist to the engineer. The editors have conceived a blueprint of the whole industry divided into five main sections: Economics and Future Trends, Unit Operations and Design, Refining Processes, Petrochemicals, and Mechanical Equipment.

Unfired Pressure Vessels, *Chapter VI, part of API Guide for Inspection of Refinery Equipment, published by the American Petroleum Institute, 50 West 50th Street, New York 20, New York. Pages 47. Price $2.*

Chapter VI, a guide to inspection of unfired pressure vessels in refinery service, covers common methods and materials of construction; construction standards and inspection in service; reasons for inspection; causes of deterioration; frequency and time of inspection; and methods, tools, and limits of inspection.

Fired Heaters and Stacks, *Chapter IX, part of API Guide for Inspection of Refinery Equipment, published by the American Petroleum Institute, 50 West 50th Street, New York 20, New York. Pages 56. Price $2.*

Chapter IX covers general design of box-type, vertical, and special heaters and of smoke, flare, and blowdown stacks; reasons for inspection; causes of deterioration; frequency of inspection; safety precautions; and many other important items.

API Specification for Mechanical Drive Steam Turbines for General Refinery Service, *published by the American Petroleum Institute, 50 West 50th Street, New York 20, New York. Pages 28. Price $1.50.*

Specification gives minimum requirements for general-purpose and special-purpose horizontal, vertical, condensing, or non-condensing mechanical drive steam turbines. Design, materials, inspection and tests, preparation, shipment, erection, drawings and other required data and proposals are covered.

Fundamentals of High Polymers, *by O. A. Battista, published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages 140. Price $5.50.*

This condensed, fundamental text covers every important area of high polymer science. It is well written for those who need a basic knowledge of this vast field. It presents all types of high polymers in a manner especially suited to the non-specialist. A general bibliography provides an extensive guide to published literature.

Biological Treatment of Sewage and Industrial Wastes, *Vol. II, by Joseph McCabe and W. W. Eckenfelder, Jr., published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages 330. Price $11.50.*

This is the second volume in a series covering entire field of biological waste treatment. It records the proceedings of the Second Conference on Biological Waste Treatment held at Manhattan College. It includes 28 papers, contributed by leading authorities and arranged in logical sequence. Three separate sections cover: Anaerobic Treatment, Sedimentation and Floatation, Vacuum Filtration and Sludge Conditioning.

ASTM Manual on Measurement and Sampling of Petroleum and Petroleum Products, *Third Edition, published by the American Society For Testing Materials, 1916 Race Street, Philadelphia 3, Pennsylvania. Pages 158. Price $3.50 (nonmember) and $2.80.*

This manual presents under one cover available information for measuring quantities of petroleum and its products, and for obtaining representative samples thereof. Methods have been revised in this third edition to improve their usefulness and practicability. They are written concisely, yet in sufficient detail to permit the procedures to be followed without further instruction.

Fluorocarbons, *by Merritt A. Rudner, published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages 238. Price $5.75.*

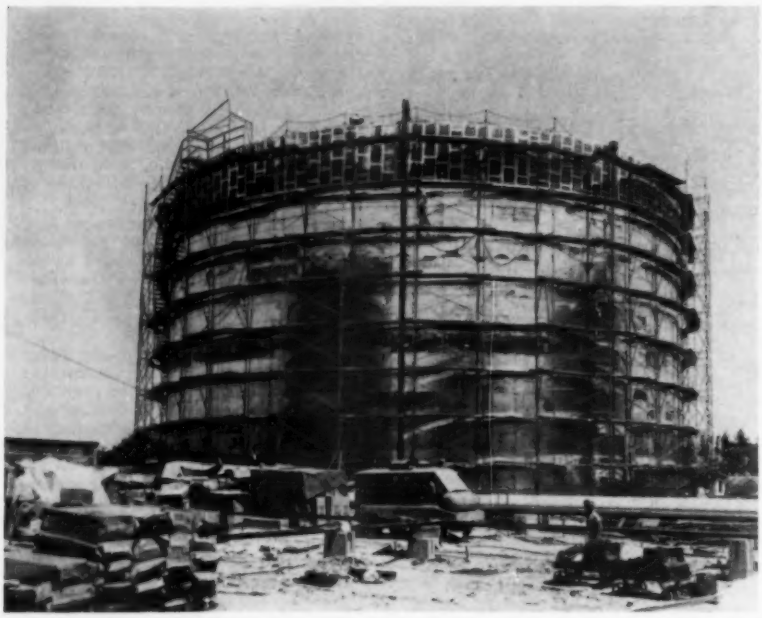
Properties, chemistry, processing and fabrication techniques and final applications of fluorocarbons are completely covered in this book. It demarcates the efficient use of these materials by describing their capabilities and limitations as compared with other plastics. Book abounds in helpful charts, tables of processing data and illustrations.

ASA Revision of American Standard B16.5 for Steel Pipe Flanges and Flanged Fittings, *published for American Standards Association, Dept. PRI, 70 East 45 Street, New York 17, New York. Price $3.*

Revision deletes Class B pressure-temperature ratings contained in the previous version of the standard and gives further clarification for remaining rating class, formerly Class A. An appendix defines gasket qualifications suitable for pressure-temperature ratings and another defines method of calculating lengths for bolts by establishing stud-bolt lengths from thread-to-thread, leaving out the height of points. Pressure-temperature data for a number of new materials and other information have also been added.

CALCULATE FUEL OIL STORAGE TANK HEAT LOSSES

Kenneth M. Ritchie, *Baldwin-Hill Company, Trenton, New Jersey*



Metal sheathing approaches the top of a 100-ft diam fuel oil storage tank. In the upper portion, not yet covered, can be seen block insulation pointed with insulating-finishing cement, to insure thermal integrity.

DESPITE the relatively low temperatures involved, the need for insulating fuel oil storage tanks is often dictated by practical economics. For example, No. 6 fuel oil, probably the most commonly used industrial fuel oil in this country, must be stored at or above 120 F. This is not a high temperature by most standards, but large outer surface area, and comparatively high rate of heat loss due to outdoor location, make insulation of heated bulk storage units desirable. Tank insulation becomes more important when storing liquids even more viscous than No. 6, requiring even higher storage temperatures.

The example (Table 1) illustrates annual dollar savings for insulating a large bulk storage tank in a temperate zone climate. By covering this theoretical tank with 2 in. thick insulation blocks, as much as $72,255 in heating costs may be saved in a single year.

Cost of heating larger and smaller tanks operating at the same temperature and under the same ambient conditions will vary directly with tank surface area. Costs will also vary with different storage temperatures and climatic conditions.

In the example shown in Table 1, the tank stores fuel oil at 140 F, and is 120 ft in diam and 48 ft high. Its surface emissivity factor is assumed to be 0.90. Ambient conditions assumed in the problem seem reasonable when compared to Table 2, which lists mean temperatures and wind velocities for various cities.

Table 1. Cost Comparison for Heating Bare and Insulated Fuel Oil Storage Tank.

BASIS			
Diameter	120 ft	Mean ambient air temperature	50 F
Height	48 ft	Mean wind speed	10 mph
Surface area	29,405 sq ft	Cost of heat per million Btu	$0.60
Hot surface temperature	140 F	Thermal conductivity of insulation	0.33

Type of insulation	none	Block-type
Thickness of insulation	0	2-in.
Heat loss, Btu/hr per sq ft	483	15.40
Annual heating cost at $0.60 per 1,000,000 Btu (8,760 hr/yr)	$74,635	$2,380
Annual savings[1]	—	$72,255

[1]This does not include amortization of the insulation.

Table 2.

City	Mean temperature[1] deg F	Mean hourly wind velocity[2] mph
New York, N. Y.	53.4	14.5
Buffalo, N. Y.	47.5	14.6
Baltimore, Md	57.1	9.9
Atlanta, Ga.	62.2	9.8
Chicago, Illinois	50.1	10.7
Kansas City, Mo	56.1	10.1
Houston, Tex.	70.0	10.0
Los Angeles, Calif.	60.9	6.1

[1]Yearly mean temperature based on U.S. Weather Bureau statistics, 1921-1950.

[2]Yearly mean hourly wind speed, U.S. Weather Bureau statistics.

Calculations were based upon these equations:

$$U_r = .172 \times 10^{-8} \times e\,(T_s^4 - T_a^4) \quad \ldots\ldots\ldots\ldots (1)$$

$$U_c = (t_s - t_a)\,(1 + .225\,v) \quad . (2)$$

$$U = \frac{t_h - t_a}{\frac{x}{k} + \frac{t_s - t_a}{U_r + U_c}} \quad \ldots\ldots (3)$$

$$t_s = t_h - \frac{x}{k}\,(U) \quad \ldots\ldots\ldots (4)$$

where:

k = thermal conductivity of block insulation at its mean temperature, Btu, in./hr sq ft F

t_a = ambient air temperature, deg F

t_h = hot surface temperature, deg F

t_s = outside surface temperature, deg F

T_a = ambient air temperature, deg R

T_s = outside surface temperature, deg R

$U = U_r + U_c$ = overall heat transmission or surface heat loss, Btu/sq ft per hr

U_c = surface convection loss, Btu/sq ft, per hr

U_r = surface radiation loss, Btu/sq ft per hr

x = insulation thickness, inches

v = wind velocity, ft/sec

e = emissivity

These equations were applied this way:

Heat loss from the uninsulated tank was computed by adding U_r and U_c from formulas 1 and 2, with $T_a = 600R$ and $t_a = 140$ F.

Total heat loss in the three insulated conditions was found by balancing overall heat transmission (U) and surface heat loss ($U_r + U_c$). Cut-and-try calculations were used for all four formulas in this manner:

Step 1 — Assume an outer surface temperature for the insulation and calculate U_r and U_c from formulas 1 and 2.

Step 2 — Substitute in formula 3 and solve for U, using a thermal conductivity of .33 which is reasonable for the probable range of mean insulation temperatures. U should very nearly equal $U_r + U_c$.

Step 3 — Calculate t_s by substituting in formula 4. If the calculated t_s is within ± 1 deg of the t_s assumed in step 1, the values are acceptable. If not, substitute the calculated t_s in formulas 1 and 2 and repeat steps 1, 2, and 3 until this condition is met.

Calculated heat loss figures should be conservative, since loss from the roof is assumed to be the same as from the sides. Actually, losses from the roof will be greater than from the sides.

Full realization of savings to be gained by insulating tanks will, of course, depend upon efficiency of the thermal barrier. Primary considerations here are selection of insulating material, the structural stability of the heat barrier, and integrity of the weather seal.

Material selection. Block insulation is a practical and economical choice. Its high degree of structural strength eliminates the need for complex attachment methods. Resilient blocks resist fracture and abrasion in handling.

Erection. Method of securing the insulation is very important from the standpoints of maximum thermal efficiency and installation permanence. Primary erection consideration is establishment of a tight thermal seal, having structural stability and provision for thermal expansion of the tank.

Large size blocks are laid with their long dimension parallel to the vertical axis of the tank; adjacent blocks are staggered. All are held against the surface of the tank with steel expander strap. Joints between the blocks are pointed with quick-setting insulating-finishing cement.

Thermal expansion. Subsequent thermal expansion of a tank can be compensated by attaching the insulating wall in separate, independent sections. None of the individual sections, separated by horizontal and vertical members which support the insulation, need accommodate more than one inch of expansion in either direction.

Steel angles, welded to the shell, encircle the tank and serve as shelves to support the blocks. The angles are spaced so that, between adjacent shelves, total longitudinal expansion of the tank will be less than one inch.

Vertical rods, welded at intervals around the vessel circumference, support insulation horizontally. Welding studs space the rods away from the tank surface. The rods anchor the expander strap stretched between them. They are spaced so there will be less than one inch of circumferential expansion between adjacent vertical support rods.

Thus, no part of the insulation sustains the tank's total thermal expansion in either direction. Blocks covering each section of tank surface, between adjacent angles and rods, are independent of blocks in other sections. If the blocks have been tightly applied, they will adjust easily to this limited increase in surface area, as will the expander strap.

Weatherproofing. Use of sheet metal sheathing is popular, and probably the most effective method of weatherproofing insulation on cylindrical vessels. Either galvanized sheet steel or sheet aluminum may be used.

Sheets are applied with the long dimension horizontal, supported by each other and by the horizontal angle shelves which also support the insulation. Vertical joints are flat-lock seams joined with sheet metal screws. The plain edge of the "locked-in" sheet is penetrated by screws through pre-punched holes, slotted horizontally to allow the sheet to slip along with circumferential expansion of the vessel.

Horizontal seams between adjacent rings of metal sheets are lapped, with the overlapping upper sheet supported from below by an "S" clip hung on the top edge of the lower sheet. Sheet metal screws join the overlapping sheets. Here, the pre-punched screw holes in the overlapped lower sheet are slotted vertically to allow for longitudinal expansion of the tank.

Care must be taken in the selection of screws, washers, clips, and other metal material so that no galvanic corrosion will occur between adjacent parts.

Tank roof. Insulation can be secured to the roof of the tank by impaling the insulation blocks over upright studs welded to the roof and securing them with speed clips. This same method of attachment can be used on sidewalls wherever projections prevent use of steel strap, such as alongside stairways.

Aluminum sheets or roofing secured by sheet metal screws or welding studs may be used for weatherproofing tank roofs. Or, they may be weatherproofed by application of two courses of 15-lb roofing felt followed by a final layer of 55-lb roofing felt. Type of weatherproofing used on the roof is often influenced by the foot traffic expected in service.

Whatever method is used on the roof, sheet metal flashing should be installed at the junction of sidewalls and roof to insure that water cannot run behind sidewall sheathing and penetrate the insulation behind it. Flashing must also be used to prevent intrusion of water at any break in the metal jacket required by a projection from the tank surface. ★ ★ ★

Refining Personals

Dr. R. N. Maddox

▸ **Dr. Robert N. Maddox** has been named head of the Oklahoma State University School of Chemical Engineering. He has been acting head since May 1957. Maddox, 32, has been a member of the OSU engineering faculty since 1950. Maddox has served as consultant for a number of Oklahoma industries, particularly in use of electronic computers to design petroleum handling facilities.

▸ **W. F. Brown** has been promoted to manager of manufacturing for Continental Oil Company's Rocky Mountain region. Formerly assistant regional manufacturing manager, he succeeds **J. E. Fenex**, who retired May 31.

▸ Promotions in Humble Oil & Refining Company's Baytown Refinery are **James Harrop** and **H. H. Meier** named assistant managers. Harrop is responsible for the coordination and blending, technical, employee relations, medical, accounting and plant protection divisions. The operating, utilities and oil movements, and mechanical and construction divsions are under Meier. **H. F. Goss** has been named operations advisor to Mr. Harrop and will work on special assignments. **W. B. Franklin** heads the new technical division and **H. F. Hartman** becomes mechanical and construction superintendent. **Ralph G. Sharpless** was promoted to senior engineer in the technical division.

▸ **R. E. Luton,** vice president of refining of the Ohio Oil Company, has been elected a director of the company to succeed **H. C. King** who retired July 1. King, vice president of finance, will complete a career of more than 37 years' service with Ohio Oil. Luton has been active in Ohio Oil's refining management for more than 30 years.

▸ **C. C. Brumbaugh,** director of engineering for Diamond Alkali Company since June, 1954, has been appointed a vice president. Named to succeed Brumbaugh is **Robert C. Sutter,** operations manager of Diamond's Chlorinated Products Division.

▸ **John B. Duckworth** is the new research coordinator in the Standard Oil Company (Indiana) research department at Chicago. His former position was director of automotive research at the company's Whiting, Ind., research laboratories. Succeeding Duckworth will be **Harold R. Taliaferro,** section leader in the automotive research division. **Lamont Eltinge** is being advanced to section leader, replacing Taliaferro. **Theodore O. Wagner** succeeds Eltinge as group leader.

▸ **W. J. Deevy** and **Ray Shannon** announce the formation of a partnership, Deevy and Shannon, Consulting Engineers. They will offer engineering and design services to the process industries of southeast Texas and southwest Louisiana.

▸ **C. Willis Stose** has been appointed manager of The Atlantic Refining Company's Philadelphia refinery. He succeeds

C. W. Stose

D. T. Shaw

D. T. Shaw, manager of the refinery since 1952, who is retiring after 29 years of service with the firm. Stose's previous position was that of general superintendent.

▸ **Albert W. Sublett** has been appointed assistant supervisor for light oils planning in the manufacturing department planning division of Standard Oil Company (Indiana) Chicago general offices. Employed with Standard since 1947 he was formerly assistant general foreman.

▸ **John C. Anderson** has been appointed controller for The Vickers Petroleum Co., Inc. Former controller for Pontiac Refining Corporation, Corpus Christi, Texas, Anderson has had a wealth of oil industry and management experience.

▸ **Wayne A. Proell** was named to the position of division director in the Standard Oil Company (Indiana) research department in charge of work on solid propellants used in missiles and jet aircraft. His former position was that of section leader, a position he held since 1955.

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DU PONT *Petroleum Chemicals* NEWS

Number 90 in a Series of Bulletins for the Petroleum Industry

AUGUST 1958

Demand for continuous on-stream blending prompts this Du Pont service

"Dacron"*, made in part from oil, serves the well dressed executive

Suits made with Du Pont "Dacron" polyester fiber offer advantages to the businessman. Those to whom neat appearance and comfort are important are broadening the world market for "Dacron"... and so for petroleum.

The prime quality of "Dacron" (often combined in fabrics with other fibers) is neat appearance. Such fabrics have remarkable *crease-retention* and *resistance to wrinkles.*

Suits made with "Dacron" are easy to care for. All are dry cleanable and many come in wash and wear constructions. Winter weight fabrics are warm, and those for summer are extremely cool.

Chemical companies

Du Pont, manufacturer of "Dacron" and nylon, also an oil derivative, is growing as a consumer of petroleum. So are other chemical companies which make synthetic fibers. As demand for them increases, this market for petroleum will expand.

*"Dacron" is Du Pont's trademark for its polyester fiber.

It used to be a simple matter to blend a little casinghead or cracked gasoline with the straight run from the stills. But today...

Every refiner faces the problem of blending from 4 to 10 components into his gasoline from an even greater number of production sources—plus an increasing array of dyes, inhibitors and other additives.

To help you meet this heavy—and rapidly growing heavier—blending load, the Du Pont Petroleum Chemicals Division now offers an impartial consultation service on continuous on-stream blending.

B. G. CRANE (in dark suit) inspects console used in automatically taking tank farm temperatures and gauges. These figures are fed to a computer which automatically converts them to volumes corrected to 60° F. The information is automatically printed three times a day on inventory report forms. Instantaneous gauging information on any tank can be obtained by the operator at the throw of a selector switch.

Trend to automation

The petroleum industry has always been a leader in the trend to automatic processing operations. But one large area left for improvement in product handling is the tank farm and light oil dispatching, blending and loading operations.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT *Petroleum Chemicals* NEWS

CONTINUED *Continuous Blending*

Now, the adoption of continuous blending of motor fuel is one of the last steps to achieve straight-through handling of all refinery products and elimination of the need for intermediate storage.

What you gain

In comparison with *batch* and *partial* blending methods, the *continuous on-stream* method offers many advantages. Refiners who are now using the automatic continuous method report that they are successfully realizing all, or most, of the following benefits:

1. Increased tank utilization
2. Elimination of reblending
3. Elimination of quality giveaway
4. Reduced loss of light ends
5. Blending closer to ultimate specifications
6. Flexibility in maintaining inventory in base stocks
7. Lower power costs
8. Reduced inventory of TEL and other additives in finished gasoline
9. Simplification of butane shrinkage factor
10. Increased safety

RATE CONTROL VALVES in the automatic gasoline-blending manifold and stock solution tanks used for the continuous injection of additives.

To help you

If you are considering setting up either a partially or completely automatic continuous blending procedure at your refinery, we believe it will pay you to consult with Mr. B. Gardner Crane, our Petroleum Chemicals Division authority on continuous blending methods. He has had wide experience in working with a number of refiners on all aspects of continuous blending problems. You'll find his recommendations completely objective and impartial. Your local Petroleum Chemicals Division representative will be glad to make arrangements.

Space platform built with petroleum-based products predicted for future

A DRAMATIC EXAMPLE of exciting future uses of petroleum-based products developed by the chemical industry is this proposed space platform.

Rocket expert Dr. Wernher von Braun predicts that 1980 will see the first space platform built to accommodate scientific research installations.

Oil in space

Such a platform would probably be built of the same durable, economical petroleum products that are revolutionizing modern housing. The structure would be prefabricated on the ground, of oil-derived materials of plastic or rubberized nylon. The parts would then be shipped in cargo rockets into their orbit, put together, and inflated with internal pressure.

Du Pont warehouses meet emergency additives needs of "caught-short" refiners

When fire broke out recently at a mid-continent refinery, an alert Du Pont representative rushed to the scene to offer whatever assistance he could. He found that the blaze had consumed the refinery's entire stock of additives.

He phoned a nearby Du Pont warehouse, and within a few hours a new supply of additives was on the way by train, arriving next morning.

In another instance, a refinery unexpectedly ran low on gasoline dye. A rush order was phoned to a Du Pont regional office at 1 p.m. The dye was shipped from a nearby Du Pont warehouse the same afternoon. In spite of a nine-inch snowfall which blanketed the route, the truck delivered the dye before the refinery's dwindling supply ran out.

These are only two of many examples of how our well stocked, conveniently located warehouses can help you solve an additives shortage. There are seven warehouses: at Carneys Point, New Jersey; East Chicago, Indiana; Kansas City, Missouri; La Porte, Texas; Billings, Montana; Mt. Vernon, Washington; and Los Angeles, California. Each maintains an ample supply of Du Pont additives, including Du Pont Metal Deactivator, antioxidants, dyes, fuel oil additives, and grease stabilizers.

For these or similar Du Pont services, contact the nearest office in this list:

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Cleveland 15—25 Prospect Ave. . . . SUperior 1-1363
Houston 2—705 Bank of Commerce Bldg. . . . . CApitol 5-1151
Los Angeles 17—612 So. Flower St. . MAdison 4-1354
New York 20—45 Rockefeller Plaza . . . . . COlumbus 5-2342
Philadelphia 2—3 Penn Center Plaza . LOcust 8-3531
Pittsburgh 22—1 Gateway Center . . . ATlantic 1-2933
San Francisco 4—111 Sutter St. . . . EXbrook 2-1934
Seattle 3—4003 Aurora Ave. . . . . MElrose 2-6977
Tulsa 1—1811 So. Baltimore Ave. . . . LUther 5-5578
In Canada—Du Pont Company of Canada (1956) Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**—Ontario . . . . . HUdson 1-6461
In Other Countries—Organic Chemicals Department, Export Division, 7447 Nemours Bldg., Wilmington 98, Del., PRospect 4-2962.

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Du Pont Tetraethyl Lead and other Petroleum Additives

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-7352

Printed in U. S. A.

Incoming board of directors of the Natural Gasoline Supply Men's Association, elected for the 1958-59 term, took office at its first scheduled meeting in Dallas, Texas.

Members of the Board are, (l to r) seated: C. P. Stanley, Rudy Zorn, W. F. Hildebrand, W. F. Matheny, incoming President H. O. Sears, G. C. Thrift, retiring President Jimmy Dvoracek, E. L. Stark, A. F. Canada, R. P. Walker, and Jimmy Okeson.

Standing: C. Victor Bolles, F. W. Bell, J. B. Zachry, James S. Kone, Ray F. Riddle, T. R. Cross, E. O. Haltom, James E. Hughes and I. Earl Nutter.

▸ Newly-appointed patent associates of Esso Research and Engineering Company are **Charles D. Stores,** who heads Esso Research's patent office in Washington, D.C., **Peter H. Smolka** and **Seymour Stahl.** New research associates are **Albert M. Gessler** and **Erik Tornqvist.** Both are members of the firm's chemicals research division. **Walter W. Gleason** and **Robert F. Neu** have been named section heads of Esso. Gleason has been appointed head of a polymers section in the Linden firm's technical service unit. Neu is in charge of a section concerned with applications development work in chemicals research division.

▸ **V. F. Beyer** has been appointed manager of white oil and petroleum sulfonate sales for Continental Oil Company. Formerly director of petroleum sulfonate sales, he will continue to make his headquarters in New York. **A. C. Kellerman,** sales representative for Conoco's petrochemical department, has been promoted to director of petroleum sulfonate sales.

▸ **Leonard Acquaviva** and **E. Harold Paulu** have been appointed engineering associates of Esso Research and Engineering Company. Acquaviva, with the company for 29 years, was formerly assistant chief draftsman. Paulu has been with the company for 22 years. **Charles W. Foust, Christopher E. Loeser** and **Arthur K. Scott** have also been named engineering associates. Scott, a member of the firm's planning engineering division, started his Esso career in 1936. Loeser, also a member of the firm's design engineering division, started his Esso career in 1947. Foust, with the company since 1932, is a member of the firm's process research division.

▸ **Dr. Norman Parnell,** formerly with the DuPont Company, **Murray Greyson,** previously with Houdry Process Corporation, will serve as research chemists and **Robert Stone,** recent graduate from MIT, will be an associate engineer in the Radiation Laboratory of Cities Service Research and Development Company. **Dr. Anthony Revukas,** who was formerly with Tidewater Oil Company, was appointed group leader in motor gasolines at the Cranbury laboratory.

▸ **John J. Coates,** assistant plant manager of Esso Standard Oil Company's Pittsburgh grease plant, has been promoted to manager. He succeeds **Carter Wasson,** who retires after 38 years of service.

▸ **Harold G. Mangelsdorf** has been appointed deputy coordinator of Standard Oil Company's (New Jersey) worldwide refinery activities. He is former chairman of the Jersey Standard Advisory Committee on Human Relations, a post he had held since 1956. Mangelsdorf began his career with the Jersey organization in 1934 as an engineer at Esso Standard Oil Company's Baton Rouge, Louisiana, refinery.

▸ **Daniel F. Cameron,** chief process engineer in Continental Oil Company's manufacturing department, has been selected from American industry to receive a 1958-59 Sloan Fellowship at the Massachusetts Institute of Technology.

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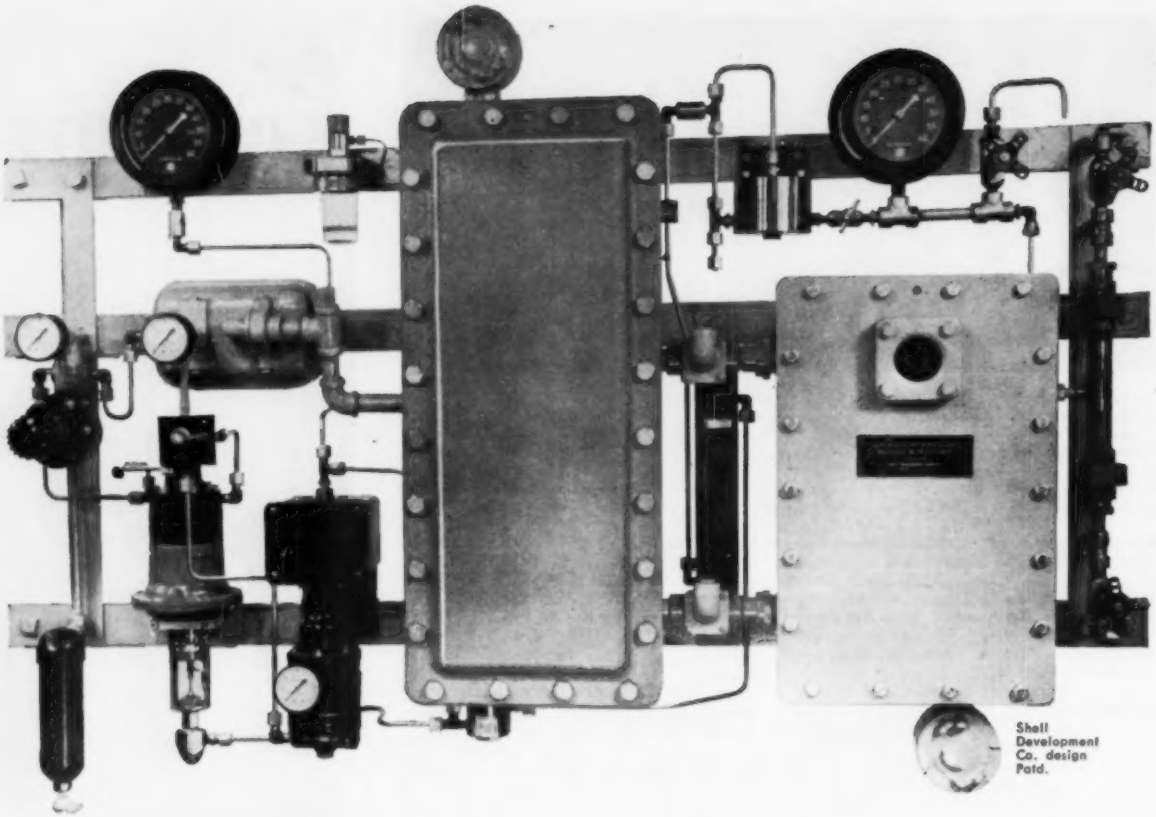

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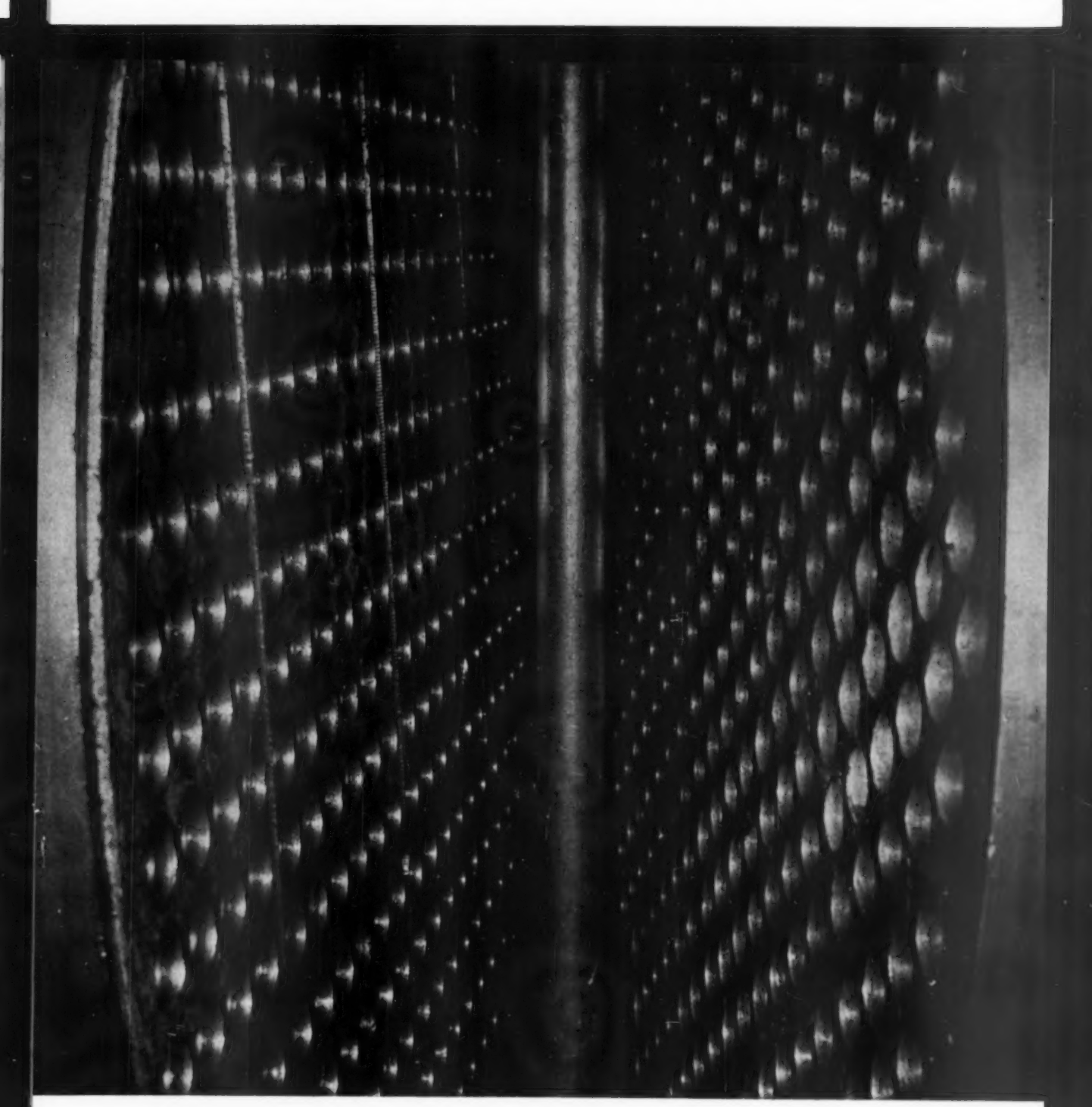

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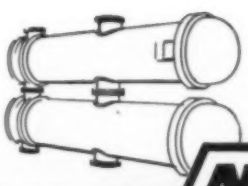

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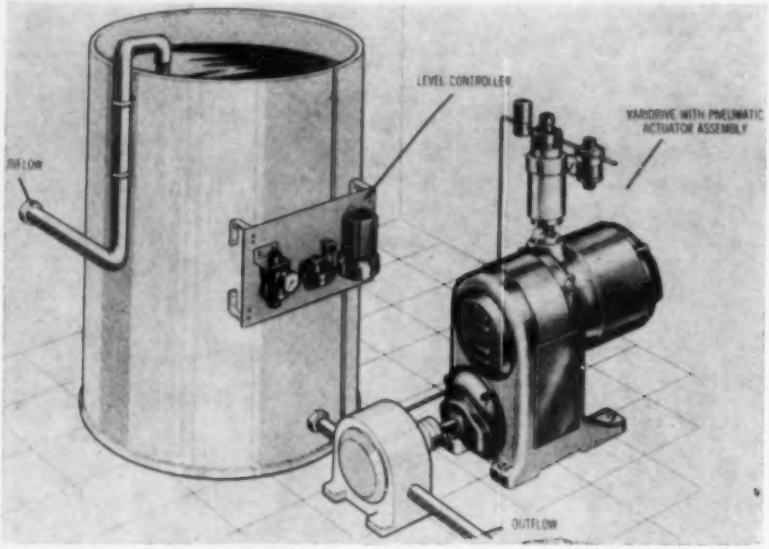

A new liquid level control system has been developed to maintain a constant level in tanks and vessels. System consists of a motor equipped with a pneumatic actuator. The motor automatically provides variable speed to the pump to maintain a constant level within the tank. New system is entirely pneumatic, contains no floats or flow restricting valves. *U. S. Electrical Motors, Inc.*

Circle number (41) on reply card.

Simplified Digital Computer

New general purpose digital computer is made available on either a lease or purchase basis. Commands and data may be stored in the computer's internal memory and commands can be obeyed automatically. Its physical size has been kept small by the use of serial logic and time sharing techniques in the internal design. *Bendix Computer-Division of Bendix Aviation Corporation.*

Circle number (42) on reply card.

Fractionator Computer

New series of analog in-process computers is announced by Southwestern Industrial Electronics Company. Reliability is said to be extremely high through elimination of all vacuum tubes, relays and servo-slidewires. Computers are used first as operational aids and later as optimizing controllers in fractionating towers or distillation columns. Process transmitters provide input data. With no exposed contacts it may be placed safely in an explosive area. *Southwestern Industrial Electronics Company.*

Circle number (43) on reply card.

Miniature Chromatograph Syringes

A new miniature syringe permits fractions of a microliter to be read directly. Internal standardization can be eliminated with this syringe, which has total capacity of 10 microliters and a total dead volume in syringe and needle of 0.5 microliter. It may be used for highly sensitive chromatographs. Syringe uses a cemented needle, 0.018 in. in diam and 2 in. in length. *The Hamilton Company.*

Circle number (44) on reply card.

Mass Spectrum Digitizer

New analog-to-digital converter has been developed to measure and tabulate peak heights from the mass spectrometer's oscillograms. It converts the amplitude and true mass number on each mass-spectrum peak — except metastable peaks — into a signal to a parallel-entry type paper-tape printer. Readout is continuously available during mass spectrometer's run. *Consolidated Electrodynamics Corporation.*

Circle number (45) on reply card.

Flowmeter Calibrating Unit

New packaged portable unit for calibrating liquid flowmeters uses turbine flowmeters as the calibrating standard. Water, hydrocarbons and/or oils are used as calibrating medium, unit is accurate to 0.5 percent of instantaneous flow rate. Range is from 0.5 to 150 gal per min. Basic design is flexible to permit tailoring to individual customer's requirements. *Fischer & Porter Co.*

Circle number (46) on reply card.

Fraction Collector Accessory

New device makes possible isolation of pure quantities of material as small as 0.0002 cc. It is an accessory for the Beckman GC-2 Gas Chromatograph and becomes a preparative tool, separating complex liquid or gas mixtures into chromatograph-pure fractions and capturing them for analysis by infrared spectroscopy or for other studies. Collector system consists of a 5 cc chromatographic column. *Beckman Instruments, Inc.*

Circle number (47) on reply card.

New Light Portable X-Ray Unit

GE has made available a light, high voltage and inexpensive X-ray unit for field and plant radiography. Named the LX-140, effective radiation protection, unitized design, simplified controls and dust and moisture proof head are claimed. Radiographs with 2 percent sensitivity and 1.5 density can be produced with a 1½ min exposure. *General Electric Company, X-Ray Department.*

Circle number (48) on reply card.

Air-Dry Protective Coating

An air-dry protective coating with process field history as a tank lining for sour crude, aromatic solvents, high octane gasoline and chlorinated solvents is being manufactured. It is applied in a film thickness of 8 to 10 mils, requiring 2 spray coats. Heavy film building properties simplify application procedure under unfavorable conditions. *Wisconsin Protective Coating Company.*

Circle number (49) on reply card.

Explosion-Proof Cable Connectors

Explosion-proof cable connector has been introduced for use with portable equipment in semi-hazardous plant areas. The aluminum housed 3-part body is guaranteed explosion proof and dust proof. To prevent strain on the wire connectors from sudden tugs on the cord, an auxiliary cord clamp is provided. *Appleton Electric Company.*

Circle number (50) on reply card.

New Steam Generator Furnace

New oil and/or gas fired pressurized-furnace steam generator designed for power, process or heating loads requiring steam capacities up to 400,000 lb per hr is being marketed. New unit claims an advanced design in "Membrane Wall" prefabricated furnace construction, which utilizes welded tubular furnace wall panels. *The Babcock & Wilcox Company.*

Circle number (51) on reply card.

UPVC Lined Fittings & Pipe

Tube Turns Plastics, Inc. and Swepco Tube Corporation have announced manufacture and sale of unplasticized polyvinyl chloride lined fittings and pipe. UPVC fittings and pipe are offered in sizes ½ in. through 3 in. The shielded piping is claimed ideal for handling corrosive fluids. When fittings are bolted together, no gasket is necessary. *Tube Turns Plastics, Inc. and Swepco Tube Corporation.*

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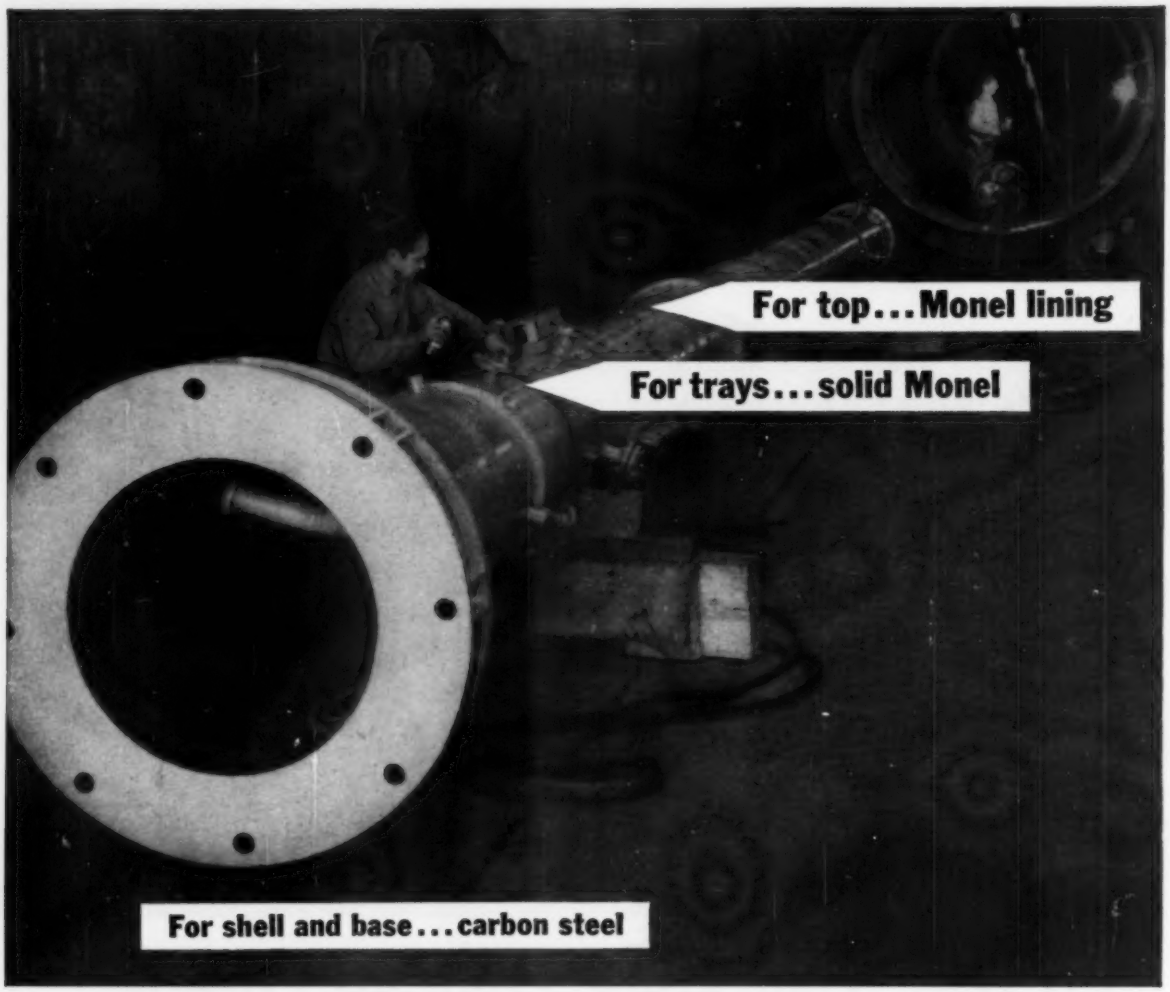

How to put tower corrosion on a "starvation diet"

Tower-top corrosion won't cause trouble in the fractionating tower shown above.

The builder of this tower, Fritz W. Glitsch & Sons, working closely with the refiner and Inco's Corrosion Engineering Section, put corrosion on a "starvation diet" of Monel* nickel-copper alloy.

They put Monel alloy at the trouble spots. Above the probable dew line (the top 15 feet, 6 inches) a 3/32-inch Monel alloy lining was used. For the trays, where agitation could intensify corrosion, a special design was employed in solid Monel alloy.

This is only one case... but it's typical of the way engineers are putting Monel nickel-copper alloy to work to resist tower corrosion by dilute hydrochloric acid and corrosive salts, at temperatures up to 500°F.

How is your tower down-time record? If it's not what it should be and tower-top corrosion is the cause, look into the possibilities of Monel alloy construction. Write Inco's Corrosion Engineering Section. Make the solution of your corrosion problem a team effort. *Registered trademark

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New Equipment

Aluminum Jacket Pipe Elbow

Right-angle turns in insulated pipelines can now be enclosed with a new aluminum jacketing product. Elbow has an almost squared-off contour which gives it ample space to fit both sharp or gently curving turns, without cutting away insulation. Twelve sizes can fit 107 combinations of pipe diam and insulation thicknesses, up to an OD of 12.81 in. *General Aluminum Supply Company.*

Circle number (53) on reply card.

FREE GUIDE TO BETTER WRITING

"How to Write Better Technical Articles" has been reprinted for the third time from *The Refining Engineer*. It's available to no cost to you. In just three fast-reading pages, it shows how to make your written material . . . letters, reports and articles . . . sparkle. Various forms of organization are compared, and important tips are provided on how to make your writing easier to read and more effective. Author John L. Kent also shows you how to speed your writing . . . an important factor when your work schedule is crowded.

Circle number (54) on reply card.

New Refining Literature

Furnace Tubes Selection Guide

Designers and engineers selecting furnace tubing for refinery and petrochemical service will find a reprint of a technical paper published by *The Refining Engineer* of interest and value. This 11-page article includes tables showing properties of different types of tubing steels commonly employed in such service. *The Babcock & Wilcox Company.*

Circle number (55) on reply card.

Cycloidal Vacuum Blowers

A new bulletin gives full information on construction and technical data on capacities and ratings of cycloidal vacuum blowers. Full-color cutaway view of the blower shows design features of the equipment. This bulletin makes it possible for an engineer to make initial selection of equipment on basis of data presented, according to *Roots-Connersville Blower, one of the Dresser Industries, Inc.*

Circle number (56) on reply card.

Flow Metering Data

New bulletin describes methods for selecting standard throats and capacities for velocity-increasing differential producers. Illustrative examples of formula application are worked out to determine such economic factors as pumping cost per year for differential producers under typical conditions. Bulletin also contains dimensional tables, capacity tables and performance charts. *B-F-I Industries, Inc.*

Circle number (57) on reply card.

Gas Turbine Data

Two new catalogs describing latest developments in gas turbine design are now available. First 28-page illustrated brochure gives complete engineering and performance data on 1150 bhp gas turbine with cutaway drawings and flow diagrams included. Second publication is a 6-page illustrated catalog describing 8700-9300 bhp gas turbine units. *Clark Bros. Co.*

Circle number (58) on reply card.

New Corrosion Inhibitor

Chromate base material inhibits boiler corrosion through formation of a continuous passivating film on metal surfaces. Material is readily soluble in water, and is supplied in 20 ounce cans. Four cans of the material for 1000 lb of water — 120 gal — contained in the boiler is sufficient. *Betz Laboratories, Inc.*

Circle number (59) on reply card.

Industrial Uses of Aluminum Chemicals

48-page booklet "Reynolds Aluminum Chemicals" describes uses of bauxites, aluminas, etc., in petroleum processing and other industries. *Reynolds Metals Company.*

Circle number (60) on reply card.

Fired Heaters Described

Colorful 8-page bulletin shows principal design features of standard types and special design fired heaters. Included are drawings and description on special fired heaters for severe services and photos of typical installations in various plants. *Struthers Wells Corporation.*

Circle number (61) on reply card.

Quoth Sir Galva-Knight:

ANOTHER WEAPON AGAINST CORROSION!

METALLIZING

Metallizing joins with hot-dip galvanizing in preventing corrosion. The Nowery J. Smith Company, already the South's largest commercial hot-dip galvanizing concern, now offers a complete, expert metallizing service as well. This means that units too massive for hot-dipping can be provided with a tough armor-coating of zinc or aluminum and these applications can be performed in the shop, in the field — even on offshore location!

Write today for descriptive literature and specifications on metallizing . . . or call UN-9-1425, Houston.

Nowery J. Smith COMPANY

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Commercial Galvanizing
Pickling, Oiling, Metallizing, Sandblasting,
Prime coating, and/or painting.

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THREAD LEAK REPAIR —QUICK, FINAL!

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure — without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.

SKINNER-SEAL COLLAR LEAK CLAMP — designed to stop every type of collar leak in oil and gas lines. Sizes: 2" to 13" inclusive.

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So SIMPLE
We Can
Adapt It
to ANY
LIQUID LEVEL
CONTROL JOB
A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.
MAGNETROL

AS DEPENDABLE AS MAGNETIC FORCE ITSELF

● No matter how specialized the liquid level control application, adapting Magnetrol to meet it presents no problem. Whether it's for high pressures, high temperatures, corrosive liquids or any other condition, a few "standard" modifications and the job is done! Operation is so simple no changes in basic design are needed. That's why Magnetrol "fits" practically any application — why "specials" are so often standard with us.

Because of the utter simplicity and dependability of its magnetic principle, Magnetrol has *infinite operating life.* There are no wearing parts to get out of order.

Magnetrols are available for controlling level changes from .0025-in. to 150-ft., with single or multi-stage switching. Our experienced engineering staff is at your service.

MAGNETROL, Inc.

WHY NOT MAIL THE COUPON — NOW

MAGNETROL, Inc., 2121 S. Marshall Blvd., Chicago 23, Illinois 7
Please send me catalog data and full information on Magnetrol Liquid Level Controls.
Name_____
Company_____
Address_____
City_____ Zone____ State____

New Literature

Gas Chromatography Guide

A 30-page supplement to a previously published bibliography on gas chromatography has been completed and made available. Manufacturer states that this information will enable the solving of chromatographic problems more readily and will increase usefulness of chromatography. *Consolidated Electrodynamics Corporation.*

Circle number (62) on reply card.

Calculating Press-Temp Ratings

New 48-page bulletin summarizes and correlates various ASA and ASME Code specifications for use as an aid in computing minimum safety requirements for designing pressure piping systems. Bulletin is designed to eliminate most of the tedious and time-consuming arithmetical procedures usually involved in computations such as those for determining requirements for maximum allowable stress an nominal wall thickness. *The Babcock & Wilcox Company.*

Circle number (63) on reply card.

Chemical Intermediates Booklet

An 18-page booklet describes 18 intermediate chemicals — some commercial and others experimental — which are regarded as having research possibilities. Booklet gives physical and chemical properties and lists suggested applications for each chemical. *U.S. Rubber, Naugatuck Chemical Division.*

Circle number (64) on reply card.

Udex Process Economics

Data on the Udex process for solvent extraction of benzene, toluene and xylenes from refinery streams or coke-oven light oil are summarized. Included are statistics on aromatics production trends, a flow sheet, data on yields, estimated chemical and utility requirements and operating cost estimates. *Universal Oil Products Company.*

Circle number (65) on reply card.

Bent Tube Boilers

A colorful 21-page bulletin describes how a wide variety of industrial users of steam for power, processing or heating have found tow-drum type boilers to be an answer to their diverse steam generating requirements. In each unit a large proportion of boiler surface is exposed to the furnace. Furnaces are designed to assure proper combustion of fuels fired in suspension or with stokers. *Henry Vogt Machine Co.*

Circle number (66) on reply card.

Flowmeter Handbook

A 15-page variable-area flowmeter handbook giving basic engineering data is available. Handbook includes tables, graphs and equations for application, sizing and flow rate calibration prediction of low flow rate rotameters. *Fischer & Porter Company.*

Circle number (67) on reply card.

New Acetylene Process

Publication of a 6-page brochure describing new acetylene processes has been announced. Brochure describes processes developed to produce high-purity acetylene from natural gas or from naphtha and other liquid feedstocks. It includes a general flow sheet, discusses two types of burners used, the recovery system and feedstocks. Other information gives summary of direct operating costs and economics of acetylene production. *The M. W. Kellogg Company.*

Circle number (68) on reply card.

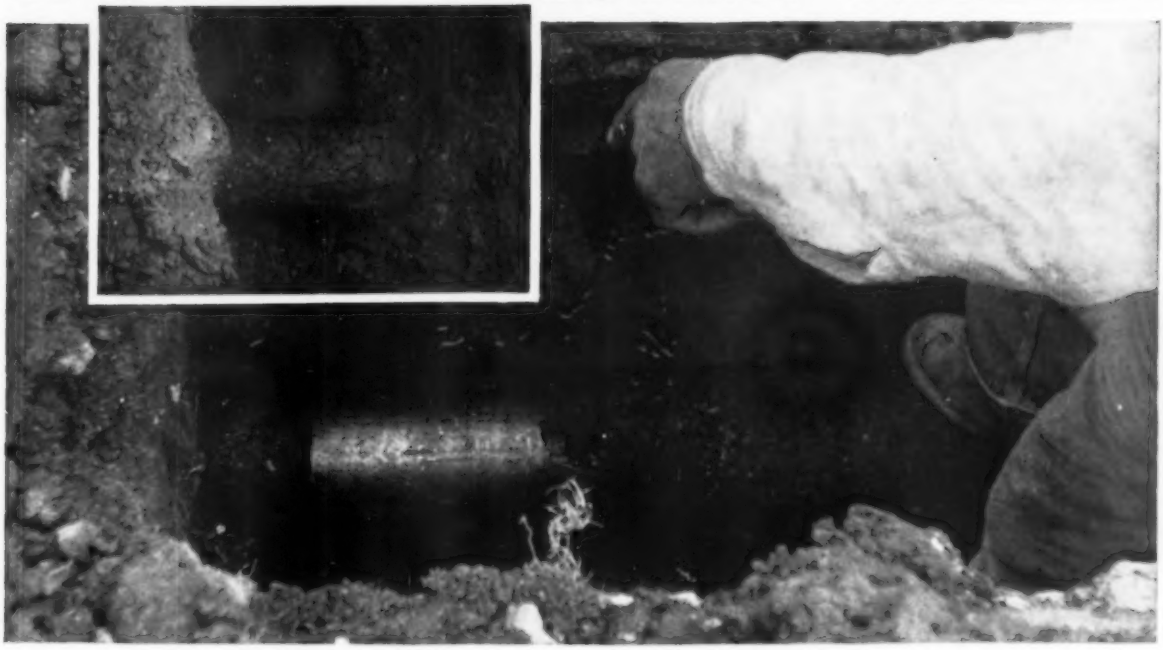
Free . . . Circular Slide Rule

We tried it, and it works just fine! It's pocket-sized, includes easy instructions on how to multiply and divide. Be sure to put your title and company on our reply card. *General Industrial Company.*

Circle number (69) on reply card.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

17-YEAR PROTECTION RECORD!



Year After Year...More Evidence Proving That TAPECOAT® Adds Years of Service Life to Gas Lines Underground or Under Water

Right across the country, TAPECOAT installations prove that you get more for your money when you measure pipe protection with a calendar.

Since this cost-cutting coal tar coating in tape form was first introduced in 1941, it has demonstrated its ability to withstand severe conditions underground or under water. TAPECOATED lines dug up after 17 years of service show no signs of deterioration on the pipe.

Typical is the experience of a utility in a coastal area. For a thorough trial, this company applied TAPECOAT in areas where severe corrosive conditions were known to exist. The lines were dug up this year and, after years of service under severe conditions such as brackish waters and corrosive soil, the pipe showed no signs of corrosion, proving the quality of TAPECOAT protection.

In terms of preventive maintenance and replacement costs, performances like this emphasize the most important consideration in buying protection. Remember, TAPECOAT is a hot-applied coal tar coating in tape form—designed for lasting protection on pipe, pipe joints, service connections, mechanical couplings, fittings, insulated lines, tanks, tie rods, and other steel surfaces vulnerable to corrosion.

TAPECOAT comes in rolls of various widths and is available in asphalt. Where primer is desired, specify TC Primecoat, the compatible coal tar primer.

A TAPECOAT sales and service engineer is always available to help you on any corrosion problem. Write for complete details today!

The TAPECOAT *Company*

ORIGINATORS OF COAL TAR COATING IN TAPE FORM

1533 Lyons Street, Evanston, Illinois

REPRESENTATIVES IN PRINCIPAL CITIES

We're Guided By Service As Well As Performance

IN STANDARDIZING ON GASO PUMPS

Let's face it. It isn't pumps but *pumping service* that we buy when we place a pump order; and it's service that sold us on Gaso Pumps. Service that starts with intelligent recommendations by nearby distributors. Service that continues through years of dependable performance. And service that extends, in many cases, a quarter-century beyond the purchase date, with the immediate delivery of parts for long-obsolete standard models. Because of such service, Gaso became a habit with us...a habit we made official by specifying Gaso Pumps whenever the requirements fall within their capacity range.

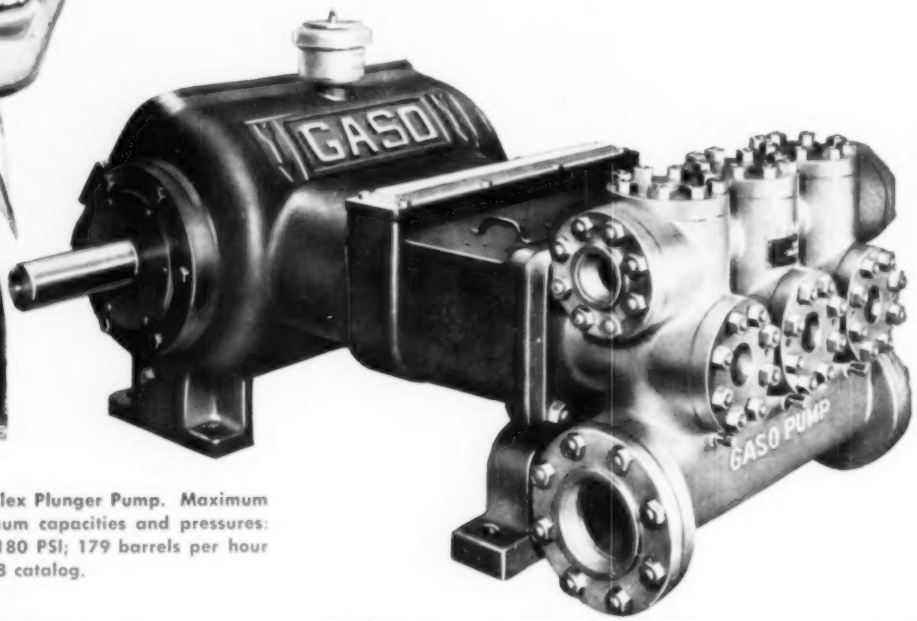


Fig. 3466 Horizontal Triplex Plunger Pump. Maximum speed, 250 RPM. Maximum capacities and pressures: 91 barrels per hour at 1180 PSI; 179 barrels per hour at 600 PSI. Write for 1958 catalog.

DISTRIBUTORS

W. L. SOMNER COMPANY, Shreveport, Louisana • Odessa, Texas • Tinsley, Mississippi • Brookhaven, Mississippi
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for every oil industry need

Ability to SELL IDEAS!

. . . engineering boldness that conveys conviction

APPROACHES are tunnels or trestles. Engineering accomplishes either.
But, Fish builds other approaches . . . the groundwork
that "sells" industrial undertakings to fit economic patterns
in the oil, gas, and chemical industries.

The men at Fish are engineers, contractors, designers,
market analysts . . . sellers. Their unparalleled power
to communicate carries conviction to peoples or public agencies.

The right approach is an element of bold engineering
to facilitate mighty achievement in industry.

THE FISH ENGINEERING CORPORATION
HOUSTON
AND ASSOCIATED COMPANIES

FISH SERVICE CORPORATION • FISH NORTHWEST CONSTRUCTORS, INC.

FOR FURTHER INFORMATION ON
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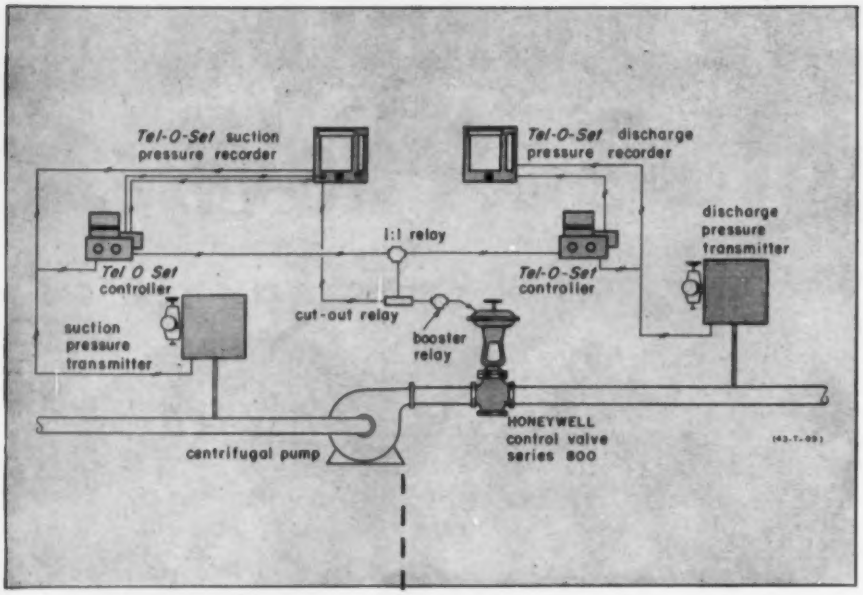
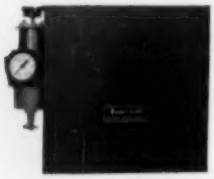
LUFKIN MACHINE CO., LTD.,
Edmonton, Alberta



Typical ***Tel-O-Set*** instrumentation for a centrifugal pump uses a combination of transmitter, recorder and controller for both suction and discharge pressure. Systems are interlocked through a relay to operate a Honeywell Series 800 control valve.

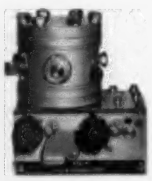


Transmitter

sends air signal to recorder. It's fast, accurate, compensated for changes in ambient temperature and pressure. Zero and span readily adjustable.

***Tel-O-Set* recorder**

is accurate, sensitive, compact. All adjustments made from front of panel. Complete chassis is replaceable . . . no loss of control. 30-day chart record.



***Tel-O-Set* controller**

has fast response, is unaffected by vibration. Disconnects and detaches from mounting at turn of a single switch. Each subassembly is a precalibrated unit, interchangeable in seconds.

FULL-TIME CONTROL

...For Pipeline Pumping Stations

Put a *Tel-O-Set* control system to work on your pumps—and you're sure of uninterrupted service. When instrument maintenance is needed, the job gets done in seconds.

The reason: transmitter, recorder and controller are designed with quickly interchangeable unit sections. You just snap in a new, precalibrated unit when needed.

In performance, too, *Tel-O-Set* miniature instrumentation leads in every respect. It's accurate, sensitive, rugged. It's exceptionally easy to tune for peak operation.

Find out from your local Honeywell field engineer how *Tel-O-Set* instruments can be applied to your station. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

First in Controls

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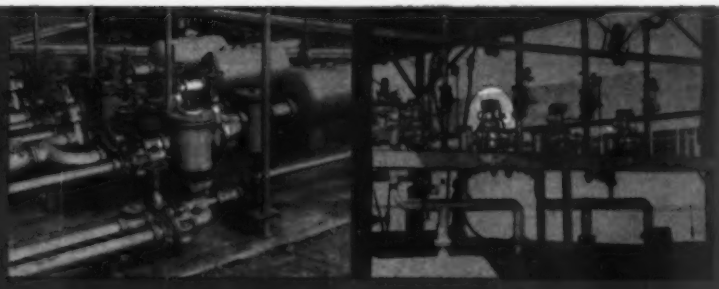
Typical Installations of A. O. Smith Meters



Perfect Auditor

for any pipeline storage or transfer point

A. O. Smith positive displacement line meters account for every drop... *print* a permanent, tamper-proof record... simplify your bookkeeping

A. O. Smith developed the first rotary meter — proven over the years in accuracy and reliability. Now, we are expanding the scope of use of these meters by utilizing them as accounting machines. Let us tell you about it. Contact your nearest representative. Or write direct.

Through research ... a better way

A.O.Smith

METER, SERVICE STATION PUMP, DIVISIONS

PIPELINE DEVELOPMENTS ★ ★ ★

Roundup of Planned and Proposed Construction

The following tables list the company, mileage, pipe size, and location of proposed pipeline projects — crude, products, and natural gas — reported to *The Pipeline Engineer*. Company addresses are given when known.

CRUDE LINES

Name of Company	Miles	Size	Location
Act Oils Toronto, Ontario, Canada	350		Line from Peace River area in British Columbia, thru Pine Pass to Prince George, westward to Bella Coola terminus on Pacific Coast
Afrique du Nord Development Societe	850	18	Hassi-Messaoud field, Algeria, to Mediterranean port
Alaska Yukon Pipe Lines, Inc.	254	—	Valdez to Tok Junction, Alaska
Alborz Oil Company	1000	38	Qum, Iran, to Alexandretta, Turkey
Argentine Government (YPF) Buenos Aires, Argentina	640	12	Campo Duran fields to Rosario
Bituminous Oil Pipeline, Ltd. Calgary, Alberta, Canada	250	—	McMurray to Edmonton, Canada
Bolivian Government (YPFB) La Paz, Bolivia	215	8, 10	Interior of Bolivia to Arica, Chile
Cape Pipe Line Company Philadelphia, Pennsylvania	200		Large diameter from Delaware Bay to Greater Philadelphia area refineries
Creole Petroleum Corp. Caracas, Venezuela	86	30	Temblador field to Caripito, Venezuela
Gillette Pipeline, Inc., and A. W. Hartwig, Inc.	102	—	Dead Horse Creek field to Casper, Wyoming
Great Northern Railway Co. St. Paul, Minnesota	600	12–20	Williston Basin to St. Paul-Duluth-Superior, Wisconsin-Minnesota area
International Oil Pipeline Corporation	900	30	International boundary near North Gate, Saskatchewan to Chicago area (continuation of Mid-Continental line)
Iraq Petroleum Co. London, England	Approx. 600		Kirkuk field to Iskenderun, Turkey
Mid-Continental Pipelines, Ltd.	600	30	Edmonton, Alberta to U. S. boundary near North Gate, Saskatchewan.
North-West Oil Pipelines Company	210		Wilhelmshaven, on the North Sea, to industrial Ruhr area of West Germany
Offshore Gathering Company Houston, Texas	364	20	Gulf of Mexico from Sabine Pass to Mississippi River
Oil Field Pipe Line, Inc. and Panhandle Eastern Pipe Line Co. Kansas City, Missouri	200	8, 12	Elkhart to Ellinwood, Kansas
Royal Pipe Lines, Ltd. Regina, Saskatchewan, Canada	288	Var.	Cantuar area fields to Glenavon
Shell Pipe Line Corporation Houston, Texas	100		Southwest Pass Terminal to Norco, Louisiana, refinery
Southern Kansas Pipe Line Company Arkansas City, Kansas	310	6, 10	Greenwood pool, near Colorado line, thru Liberal to Arkansas City, Kansas
Trans-Border Line Company	110		Skagway, Alaska, to Whitehorse, Yukon Territory
17 American, English, French and Dutch Companies	1500	38–40	Middle East producing areas to Mediterranean Coast in Turkey
Yacimientos Petroliferos Fiscales Buenos Aires, Argentina	375-434		Challaco, Neuquen Province, to Arroyo Perejas

PRODUCT LINES

Name of Company	Miles	Size	Location
American Pipe Line Co. New York, New York	1910	8–26	Beaumont, Texas, to Newark, New Jersey
Argentine Government (YPF), Buenos Aires, Argentina	585	10	Lujan de Cuyo refinery in Mendoza Province to Buenos Aires area
Hydrocarbons Pipelines, Ltd. Winnipeg, Manitoba, Canada	800	6–8	Edmonton, Alberta, to Fort William, Ontario
M.K.&T. and New York Central Railroads	2000	—	Houston-Kansas City-St. Louis-Indianapolis-Cleveland-Syracuse, New York, with branches to Chicago and Detroit
Mene Grande Oil Company Caracas, Venezuela	60	6	Anaco to Puerto La Cruz, Venezuela
Northwest Pipeline Corporation Salt Lake City, Utah	350	8–10	Four Corners to Salt Lake City, Utah
Underground Storage and Exploration, Inc. Upper Darby, Pennsylvania	393	6, 8, 12	Moundsville, West Virginia, to Newark, New Jersey, with laterals to Mauch Chunk, Marcus Hook, and Philadelphia
Union Oil Company of California Los Angeles, California	815		Shale oil plant, Rifle, Colorado, to Los Angeles area
Winnipeg & Central Gas Company Winnipeg, Manitoba, Canada	210	6	U.S. Canadian border to Winnipeg

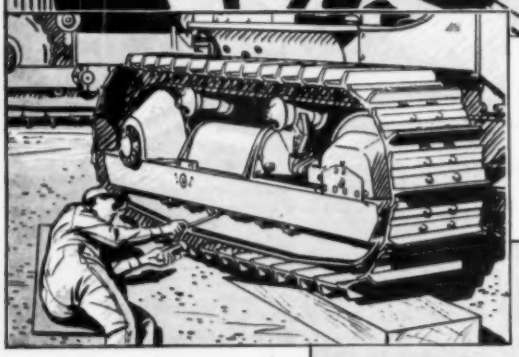
GAS LINES

Name of Company	Miles	Size	Location
Andes Pipeline Corporation	500	12	Villamontes, Bolivia, to Antofogasta, Chile
Argentine Government (YPF), Buenos Aires, Argentina	1100		Campo Duran fields to Buenos Aires
Arkansas Louisiana Gas Company Shreveport, Louisiana	300		Main and gathering lines Louisiana-Texas Gulf Coast
Coastal Transmission Corporation	574	22–26	McAllen, Texas, to Baton Rouge, Louisiana
Dallas, Texas	414	Var.	Gathering lines in Rio Grande Valley, Texas
Colorado Interstate Gas Company Colorado Springs, Colorado	917	4–34	New lines, loops, replacements in Texas, Colorado, Nebraska, New Mexico, Kansas, Oklahoma
Cuban Gas Transmission Company (Edwin Pauley) Los Angeles, California	1000		Mexico to Florida via Cuba
Eastern Shore Natural Gas Company Salisbury, Maryland	124	6, 8	Transmission line and facilities in Delaware and Maryland
Edison Securities Company Los Angeles, California	130		San Joaquin Valley to Los Angeles
Gulf Resources, Inc. New York, N. Y.	125	—	Lines and gathering system from Lopena (Zapata County, Texas) area to point in La Salle County, Texas
Houston Texas Gas & Oil Company Houston, Texas	942.6	12–30	Baton Rouge, Louisiana, to Miami, Florida Laterals to serve Florida distributors and industrial users
Iron Ranges Natural Gas Co.	120	6, 12	Mesabi Iron Range to northern Minnesota
	63	12	North Shore of Lake Superior
Kentucky Gas Transmission Corporation Charleston, West Virginia	20.5	26	To parallel existing lines in Bracken County, Kentucky
Michigan Wisconsin Pipe Line Company Detroit, Michigan	638	4–24	Laterals and loops in Wisconsin, Michigan, Missouri, Illinois, Indiana
Midwestern Gas Transmission Company Houston, Texas	2067	3–24	Main line from U.S.-Canadian border near Emerson, Manitoba—Noyes, Minnesota, to Portland, Tennessee Laterals off main line to serve communities in Minnesota, North Dakota, and Wisconsin
Natural Gas Pipeline Company of America	416	36	Loop from Beatrice, Nebraska, to Joliet, Illinois
Chicago, Illinois	337	30	Loop from Fritch, Texas, to Beatrice, Nebraska
Niagara Mohawk Power Corp. Syracuse, New York	196	2–16	Central, eastern, and northern New York
North Carolina Natural Gas Corp. Fayetteville, North Carolina	625	2–16	Intrastate line in North Carolina
Northern Natural Gas Company Omaha, Nebraska	1355	2–30	New lines and loops, Minnesota, Wisconsin, Alberta, Texas, Oklahoma, Kansas, Nebraska, Iowa
Northern Plains Natural Gas Company (subsidiary of Northern Natural Gas Company) Omaha, Nebraska	1100	26	Alberta-Montana border to Minneapolis, Minnesota
Oklahoma-Missouri Gas Transmission Company, Tulsa, Oklahoma	500	24	New system extending from Bradley, Oklahoma, district to Rolla and Webster Groves, Missouri
Pacific Gas & Electric Company San Francisco, California	1300	36	Alberta, Canada, gas fields to Antioch, California
Pacific Lighting Gas Supply Co.	83	34	From Coles Levee to Newhall
Los Angeles, California	128	—	California-Arizona border to Los Angeles
Petroleos Mexicanos Mexico City, Mexico	130	22	Reynosa to Monterrey
Piedmont Gas Co. Hickory, North Carolina	78	2–8	In Gaston, Lincoln, Catawba, Caldwell, and Burke counties, N. Carolina
Southern Natural Gas Company	144	20, 24, 26	South Louisiana loops
Birmingham, Alabama	215	Var.	Supply lines Southern Louisiana.
Tennessee Gas Transmission Company	556	30	South of New Orleans to Portland, Tennessee
Houston, Texas	76	24	Coudersport, Pennsylvania, to Hamburg, New York
	163	30	Loop from Portland, Tennessee, and Winchester, Kentucky, to Lancaster and Morehead, Kentucky
	39	26	Loop from Catlettsburg, Kentucky, to Broad Run, West Virginia
	12	26	Loop south of Mercer, Pennsylvania
	50	26	Loop from Morehead, Kentucky, to Catlettsburg, Kentucky
	350		Portland, Tennessee, to Joliet, Illinois
	21	—	Offshore gas fields to shore connections
Tensas Gas Gathering Corporation, Shreveport, Louisiana	37	2–8	Rodney field, Mississippi, to Olin Gas line connection across Mississippi River in Tensas Parish, Louisiana
Texas Eastern Penn-Jersey Corporation Shreveport, Louisiana	65	30	Loop from Delmont, Pennsylvania, to Lambertville, New Jersey
Texas Gas Transmission Corporation, Owensboro, Kentucky	92	30	Loop portions of existing system in Louisiana, Arkansas, Mississippi, Kentucky, Indiana and Illinois
	19	26	
	15	smaller	
Transcontinental Gas Pipe Line Corporation Houston, Texas	375	3–36	Main line loops, laterals, extensions to system
Transwestern Pipeline Company,	670	30	Mainline from Roswell, New Mexico, to Topock, Arizona
Houston, Texas	635	24	Two laterals from West Texas and from Texas-Oklahoma Panhandle gas fields converging at Roswell
Trunkline Gas Company, Houston, Texas	204	—	Tuscola, Illinois, to Indiana-Michigan border
United Gas Pipe Line Company Shreveport, Louisiana	202	30	Loops from southeast Louisiana to Mobile, Alabama

Your Allis-Chalmers dealer

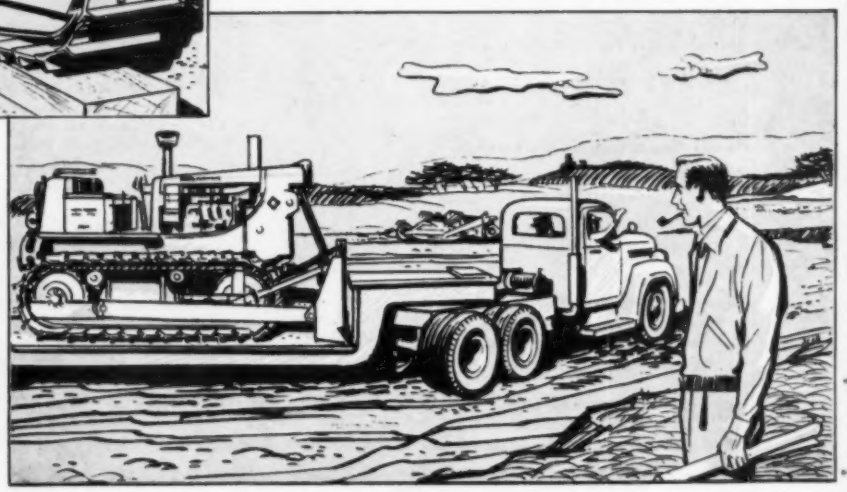
...backed by modern facilities and an experienced, well-trained staff

Your Allis-Chalmers dealer *knows* the equipment he sells. He can give you the expert service in shop and field that results in "like-new" performance from every Allis-Chalmers unit in your fleet... keeps them producing on your jobs.

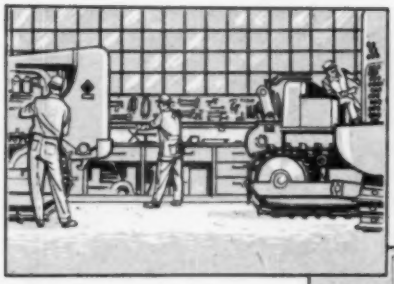


Detailed information on maintenance, adjustments and other facts on care of the machinery is delivered with the equipment. Operating tips are passed along to your men—to help them get started right and get the most from their equipment.

Careful pre-delivery servicing assures that Allis-Chalmers construction machines have been thoroughly checked ...and that they're ready for work as soon as you get them.



is a specialist in service



Shop service at your Allis-Chalmers dealer is fast and efficient—because it's handled by factory-trained men, using factory-approved tools, equipment and methods. Specialized mechanics and special facilities all help to speed service.

Scheduling checkups with your Allis-Chalmers dealer will insure that proper maintenance procedures are followed . . . stop trouble before it starts . . . keep your machines producing.

Prompt field service—a call—any time, day or night—brings a qualified serviceman and a fully equipped "mobile workshop." Result—problems can be quickly and accurately solved . . . equipment put back on the job with minimum delay.

. . . backed by a ready stock of original specification parts

ENGINEERED RIGHT

Allis-Chalmers parts are designed as original equipment . . . benefit from intensive metallurgical research. And each comes from the drawing boards of experienced construction machinery engineers.

MANUFACTURED RIGHT

Precision-made parts assure long-life service. They're made by skilled craftsmen on modern industrial machinery and are subjected to original-equipment inspection and testing.

TO PERFORM RIGHT

Each part is made of top-quality material, heat-treated to correct hardness and made to exact specifications. You can depend on them for full-capacity production on the toughest jobs you have.

The men of your Allis-Chalmers dealer organization know local conditions. Look to them for equipment recommendations to fit your job requirements . . . for true value in used machinery.

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DURIRON

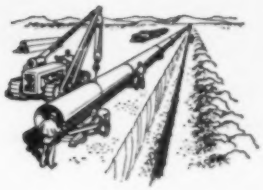
ANODE DATA SHEET

Number 2

Ground Bed

Basic engineering information about **DURIRON** *impressed current anodes for cathodic protection.*

Protection of a Pipe Line



THE PROBLEM: To protect a pipe line in a creek bed area where coke breeze could not be used due to sandy top soil and quicksand at a four foot depth. The very nature of sandy soil prevents adequate backfilling because it is very prone to caving. The original ground bed of bare scrap iron anodes had a high resistance and showed a tendency to dry out during the year. Adequate protection of the pipe line was not being achieved.

THE INSTALLATION: Twenty Duriron Type D Anodes (2" dia. x 60") were installed in two rows, 20 feet apart, with 20 foot spacing in each row as illustrated in Fig. 1. Soil resistivity averaged 2500 ohm-centimeters measured with the four pin method at 10 foot spacing. The anodes were jetted into place using a high velocity stream of water through a 10 foot piece of 1 inch pipe with the top of each anode eventually being approximately three feet below the surface (Fig. 2). Approximately 60 seconds were required to install each anode by this method. The anodes were connected to a 2/0 aluminum header, with the exception of numbers 4, 6, 16, and 17 which were connected to separate number 6 leads and were carried back to the rectifier and connected thereto with 0.01 ohm Holloway shunts. This made possible the reading of individual current values for these four anodes. The connection to the pipe line was by means of an overhead 4/0 copper cable, a distance of about 1000 feet.

THE PERFORMANCE TO DATE: This group of anodes produced 34 amperes (an average of 0.65 amp./sq. ft.) at 46 volts, and after approximately three year's time, these readings have not fluctuated appreciably. Based on initial readings, the resistance of single Type D anodes to ground is approximated by the expression $R=0.005\rho$. (R is the single anode resistance and ρ the soil resistivity in ohm-centimeters.) The loop resistance of sixteen anodes (all except the four with independent leads) was measured as 1.3 ohms; the four, together, read 3.9 ohms; and all twenty indicated 1.2 ohms. This indicates that Duriron anodes can be installed without backfill and operate at appreciable current densities with no noticeable tendency toward gas blocking. The jetting-in process used to install these Duriron anodes was reported to result in considerable savings. It would have been very difficult to install anodes in holes dug by the usual rotary drill method under the ground conditions described above, and it would also have been expensive to transport backfill to this relatively inaccessible locality.

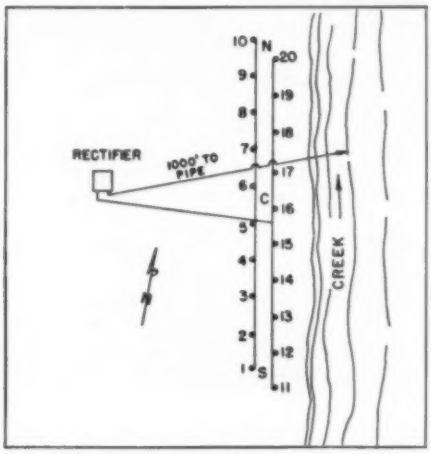
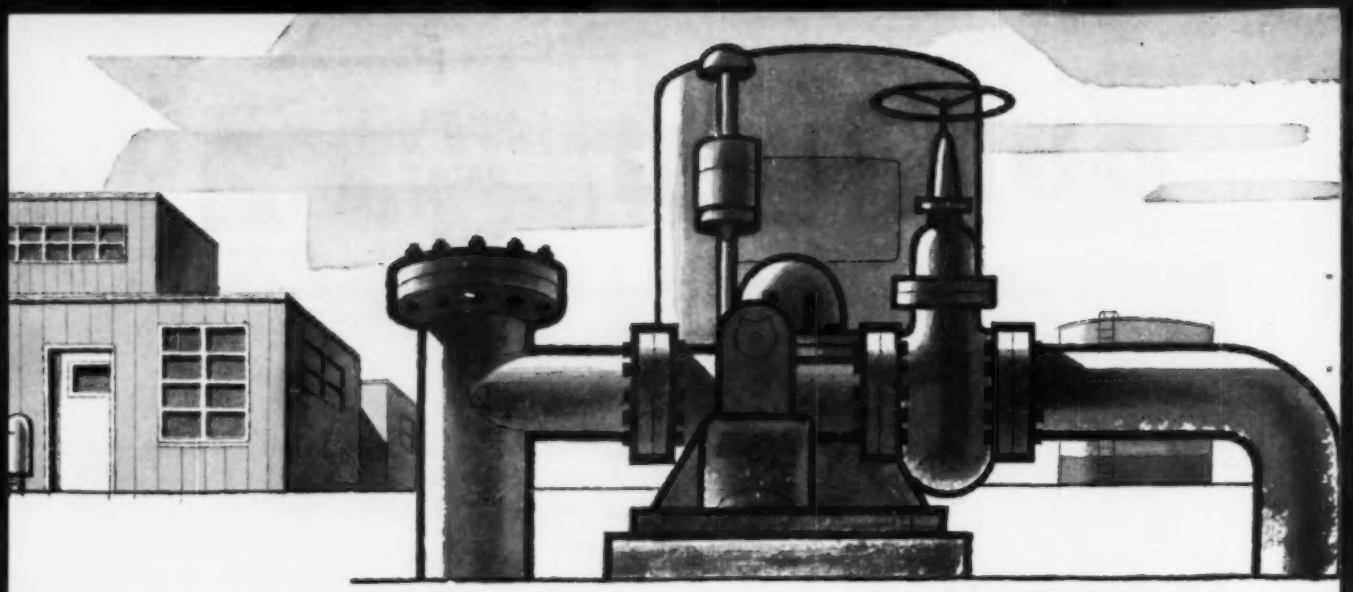


FIG. 1—Illustration of how Duriron Anodes were spaced.

FIG. 2—Illustration of jetting in process.

THE DURIRON COMPANY, INC./ Dayton 1, Ohio



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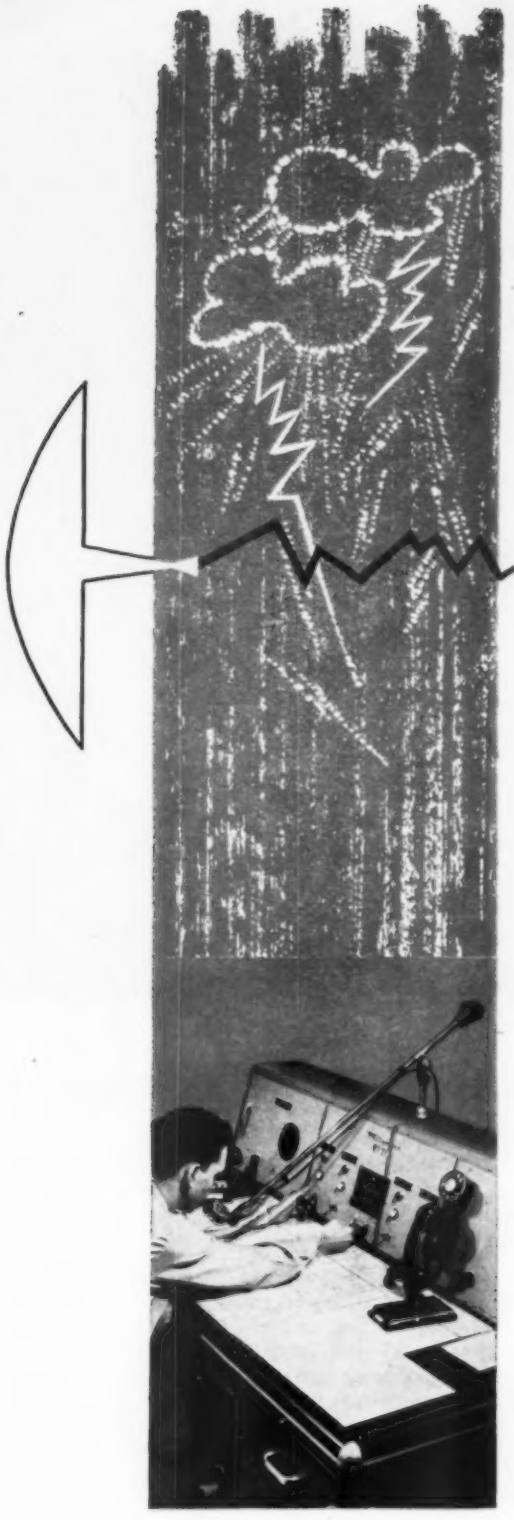

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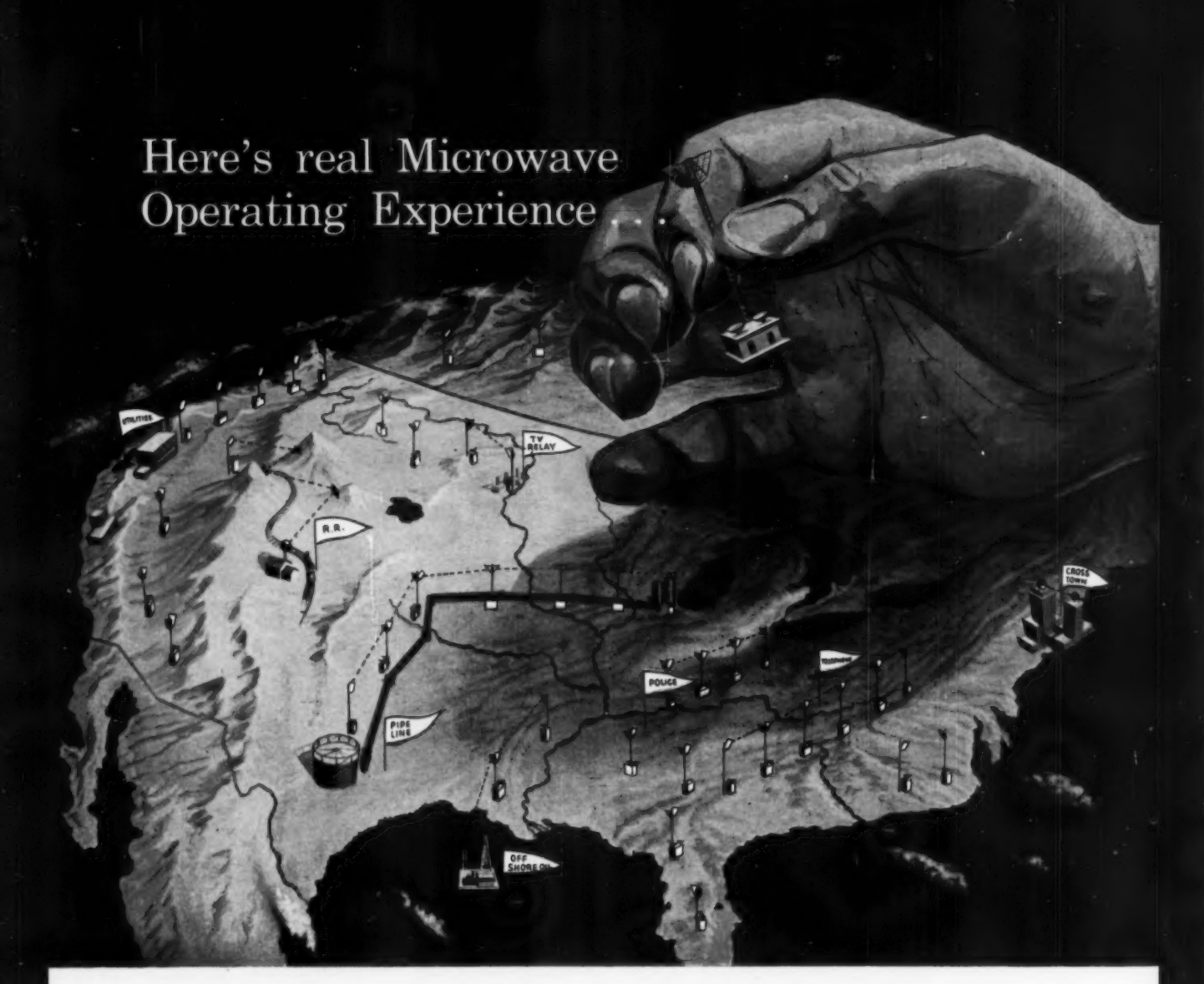

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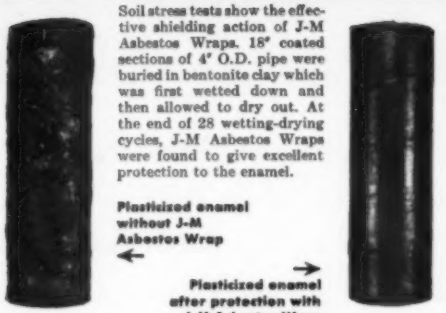

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Third, the average warranty . . . in case of a failure that does come within the limits of the guarantee . . . does not cover normal wear in the period the equipment was used, or the cost of installing new equipment.

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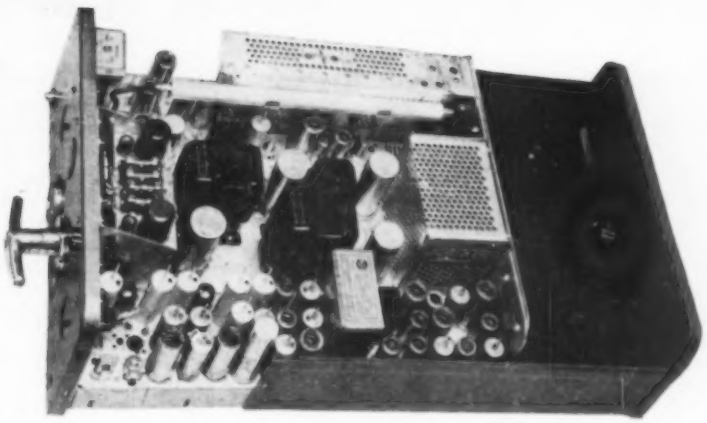
FOR OPTIMUM INTELLIGIBILITY

Designing Land–Mobile Radio Communication Systems

Here are the factors that will pay large dividends in improved performance if observed

J. R. Neubauer
Radio Corporation of America



450-mc mobile unit. (Photo courtesy RCA Communications Products Department)

THE TITLE of this article suggests a detailed treatment of the numerous equipment characteristics that effect overall system performance. In order that it not be misleading, it should be pointed out that the use of the term "systems" introduces the popular term "black box" within which a number of broadly defined elements may exist. The value of the so-called "black box" concept lies in the ability to pin-point the origin and the destination of the information to be measured.

Without becoming too involved in equipment design details, this discussion will be centered principally around the factors of noise and distortion and their effects upon the intelligibility of the output.

Included in the discussion will be a description of the methods of measurement to determine the system operating criteria. Some discussion will be included on determining the minimum intelligibility that can be used effectively in communications. Conclusions will summarize some of the techniques that can be used in planning a system for a given performance criteria.

Intelligibility Criteria

The best measure of the intelligibility of a system is how accurately it reproduces that which is inserted into it at the point of origin. In the case of a land-mobile communcation system, this is usually in the form of a single speech channel, the origin of which is a dispatcher at a fixed location or a mobile operator. We must, therefore, take into account the characteristics of the voice of the transmitting operator and the ear of the one receiving. In addition, we must consider the maximum percent of distortion and degree of departure from linearity that may be tolerated within the system.

In order that the one receiving the message may do a good job, we must consider the noise that is generated within the system and which exists in the immediate area of environment of the listener. The ratio between the usable signal and the noise that contributes to the confusion of listening will, in the end, determine the limit of performance that we may obtain. The subject of noise in itself has received much detailed treatment in the literature. We will only concern ourselves with those particular aspects of noise that we can control with our system.

To start the analysis of the reproducibility of our system, we should first examine the nature of the information being inserted by means of speech. Examination of Fig. 1, which is a curve that describes the relative amplitudes of the bands of equal articulation index for an average level of speech, shows that the maximum speech energy appears in a band of frequencies near 500 cycles. The information for this curve is derived through the use of a half-octave band analyzer, which measures the speech content within selected frequency slots of a group of average talkers.

From this curve, it may be seen that the greatest concentration of vocal energy lies in the region of 500 to 600 cycles. However, this is not the range of frequencies that contributes to the greatest degree of intelligibility. It is those frequencies appearing above 1000 cycles that enable us to obtain the greatest intelligibility, and, as can be seen from the curve, these frequencies are 10 db down from the 500 cycle point.

The index that we refer to is obtained by counting the number of random nonsense words in a specified interval that are understood when spoken, or amplified at a specific sound pressure level. To determine how this affects the one who is listening to the message, we should look at Fig. 2. This displays the Fletcher-Munson equal loudness curves that have been used to determine the adjustments for a high fidelity sound system. In order that equal sound pressure might be created in the ear for all frequencies, you will note that in the region of 60 to 70 db above the absolute threshold of hearing, the sensi-

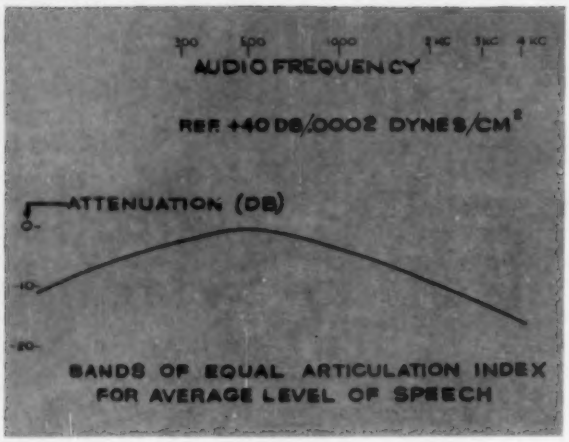


FIG. 1.

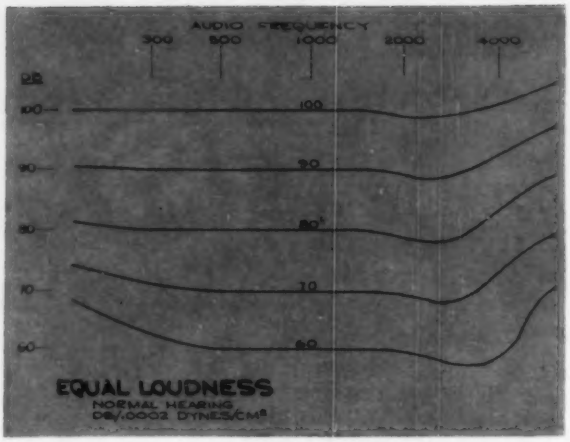


FIG. 2.

tivity of the ear to the lower frequencies is down in the region of 10 db near 300 cycles, is relatively flat between 500 and 2000, has a peak of energy in the region of 3000 to 3500, after which its sensitivity to the higher frequencies falls off quite rapidly. If we now match this curve to Fig. 1, you will realize that we have no margin of deviation from the desired range of frequencies since the speech output energy will not make up for the loss of hearing sensitivity, the ear being relatively flat through the range that speech normally covers.

It is, therefore, important that our system not introduce any non-linearity within reasonable design limits. Wherever non-linearity is introduced, it then becomes necessary to compensate for it, and in the process we may introduce new speech products in the form of distortion or noise, which will further degrade the intelligibility.

An indication of the effects of distortion on intelligibility can be obtained from tests made by the New York Fire Department, in which the accuracy of messages received over radio equipment installed in fire-fighting units was measured in the terms of decibels of loudness above the absolute threshold of hearing. When the distortion was less than 5 percent, the intelligibility was high, even though the level of noise was in excess of 106 db. Above 5 percent distortion, however, the level of intelligibility degraded rapidly — 10 to 15 db below 106 lb. In other words, the ability to read messages became less at the maximum noise level, and it was necessary to locate the loudspeaker in a position where the loss of coupling to the ear was reduced by as much as 15 db.

Radio System Characteristics

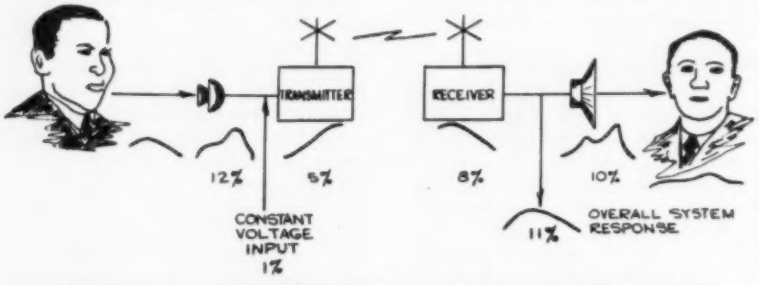
If we are to determine what contributions the radio system makes to changing the character of the speech, we will have to establish a standard method of measurement that will recognize the whole system contribution. Individual equipment tests will show each unit's contribution through a standard test device and such information is valuable in the original design of the equipment. It can also be used in the maintenance of the equipment since it provides a fixed point of reference as to performance.

The data obtained from these individual tests, however, are difficult to apply to the overall results obtained in practice. To overcome this limitation, a method of measurement is employed that uses a simulated operating system. This consists of interconnecting an actual operating transmitter through a calibrated attenuation system and utilizing techniques to isolate the transmitter from the receiver in such a manner as to be able to reduce the RF input to the receiver in measurable increments.

It is recognized that there are many leaks in such a system and stray coupling along the outside shield of the transmission line. By careful by-passing and stub detuning, however, we may eliminate the standing waves and leakage energy below the normal sensitivity threshold of the receiver. It is sometimes necessary to locate a portion of the equipment in a shielded room and to isolate the other component of the system some distance away, coupling it over a known loss length of transmission line.

To determine a system's dynamic operating characteristics, we may now inject into its audio input terminals a known type of audio voltage and measure the resulting output at the receiver terminals. In some cases, we may use standard audio phrases that contain the optimum number of vowels and consonants, such as "Joe took father's shoe box out; she was waiting at my lawn." This sentence contains the greatest portion of the vowel and consonate speech energy and, if carefully repeated in an even tone of voice, will represent a good standard speaking test. It may also be put upon a magnetic tape and looped through a play-back instrument.

Another method of providing uniform audio energy of general speech waveform is to pulse-gate a noise spectrum through a suitable filter, which shapes the amplitude of the frequency components to conform to the previously described half-octave band integrated speech spectrum. This device has been given the coined name of "VOSIM" for voice simulator. The pulse repetition rate is adjusted to simulate the average syllabic rate and the rise time characteristic is such as to nearly duplicate the enunciation characteristic of the human voice.



HOW MUCH DISTORTION CAN YOU TAKE ?

FIG. 3.

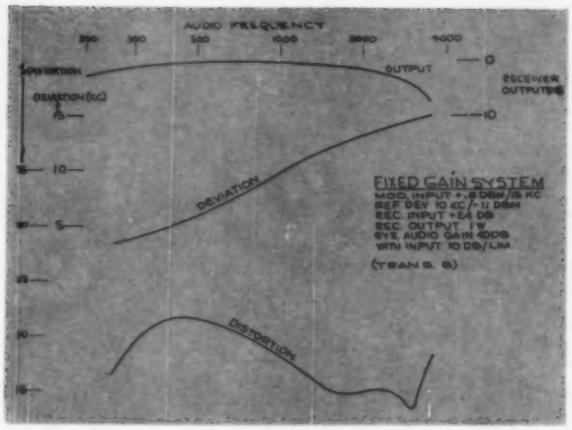


FIG. 4.

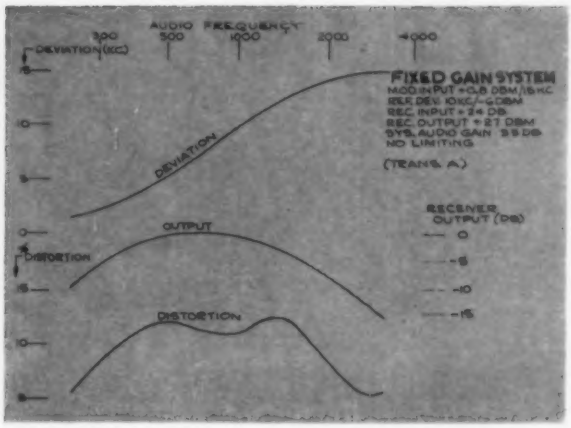


FIG. 5.

Referring to Fig. 3, you will note there are many conditions that contribute to the overall transmission characteristic of the intelligence. It is significant to note that the actual radio equipment contributes a very small percent of the total distortion, the largest distortion being contributed by the transducer element which converts the speech into electrical energy and the transponder device which converts the electrical energy into acoustic energy at the receiving point. Later in this discussion, we will demonstrate conditions that should be avoided if we are to keep the contribution of the radio equipment at a minimum.

In Fig. 3, you will also note that we have shown the relative response curves of each device. The carbon microphone is rich in second harmonic products, which rise to large values when talking loudly, as usually will be the case when an operator becomes excited or has reason to believe he is not getting through to his dispatcher. In this same respect, the distortion characteristics of the loudspeaker vary considerably from the figures shown since they will be affected by the acoustical loading, its location within the compartment of the car, and its normal resonant frequency.

The greatest amount of distortion usually will appear at about 300 cycles in an average installation and this will tend to consume a large amount of the available power. This will further degrade or muddle the desired higher frequencies. The condition becomes more aggravated as we rise the level of output in a noisy location due to the excessive amount of sound radiation from the loudspeaker enclosure itself.

Between the microphone and the loudspeaker, we have the various amplifiers, modulators, converters, demodulators, and squelch control devices that are normally contained within a regular VHF transmitter-receiver system. Each contributes its own percentage of distortion. In standard commercial design today, this is kept at a reasonable minimum. In this transmitter, however, it is possible, through maladjustment, to obtain a high percentage of distortion from the limiter that controls the deviation of the transmitter. To demonstrate this, we might compare Fig. 4 and 5.

Fig. 4 shows the operating characteristics of a fixed gain system in which no limiting is permitted in the transmitter deviation control. Under these conditions, it will be noted that the deviation of the transmitter is quite linear throughout the audio range.

The receiver audio output is considered normal for standard commercial equipment, being 3 db down at 300 cycles and 11 db down at 3000 cycles. Within this output range, the distortion, as will be noted, remains under 12 percent. As we noted from Fig. 3, the individual distortion contribution was 5 percent for the transmitter and 8 percent for the receiver.

If we now compare this with Fig. 5, we will see the effect of a system that operates well into limiting in which the limiter will be making a large contribution to additional distortion products. Here, it will be noted that the audio output of the receiver is nearly flat over the range of 300 to 3000 cycles. As desirable as this may seem, it will be noted that the percent of distortion rises rapidly in the low frequencies between 300 and 500 cycles. It is evident that this is the most desired range of audio that we wish to use. It is also evident that these frequencies will be more prone to produce undesirable speaker enclosure vibrations, which will dissipate the useful power. With undesirable radiation from the loudspeaker case, the degree of listening distortion will be increased considerably and our performance relative to the intelligibility of signals received will be degraded.

Noise is the other most important factor that contributes to system deterioration. This will appear in the output of the receiver as a product of many factors, the most frequent of occurrence being the noise generated in the power circuits and the normal circuit noise of the receiver. Dependent upon location of the receiver at the time a message is being received, the external noise will have a great deal to do with the degree of intelligence obtainable.

In the very high frequency bands, the most frequent source of external noise

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The Author

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In 1944 he was appointed supervisor of communications for Continental Air Lines. Leaving this firm in 1945, he organized the Electronic Development Corporation of Denver. In 1948 he became chief radio engineer of the Wyoming Highway Department. Two years later he moved to New Jersey to join the mobile and microwave section of RCA as a design engineer. Early in 1953, Neubauer was made supervisor of the systems communications engineering section, later becoming manager.

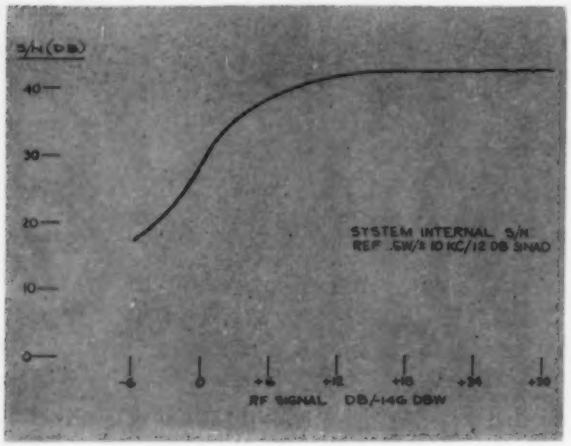

FIG. 6.

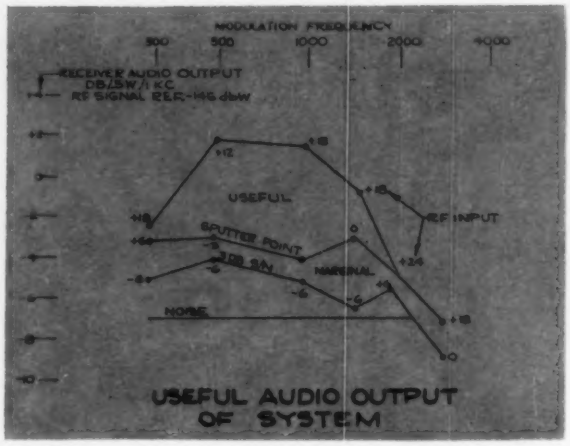

FIG. 7.

is man made, such as electrical power systems, rotating machinery, vehicular ignition systems, and similar devices, which produced very broadband, high amplitude noise of a random nature. In the absence of this type of noise, very high frequency receivers in the region of 40 mc also will be affected by galactic and cosmic noise, these having their origin in radio stars. The degree of this noise will be somewhat dependent upon the aperture of the antenna and the elevation above the horizon. This will be most noticeable on fixed station installations. Noise also may be internally generated within the system due to poor connections, poor ground returns, bad RF switches, and other forms of arcing contacts.

To gain some idea of what system performance would be required to overcome noise, reference should be made to Fig. 6, which shows a typical system internal signal-to-noise characteristic. It will be noted that in the region of the reference RF signal, which is the sensitivity of the receiver at normal SINAD threshold, noise will be on the order of 28 to 30 db. The maximum improvement that may be obtained above this point will require an increase of 12 db in RF signal input. The average amplitude of man-made interference in the 150-mc band, for example, is 5 db above SINAD threshold. This value would be obtained in the worst areas in which the unit would have to operate.

In general, the galactic noise would average approximately 4 db above the thermal noise threshold of the receiver. This could be significant in systems operating under fringe area reception conditions. For every db of noise over the referenced threshold, additional signal would have to be provided from the transmitting station in order to maintain a specified signal-to-noise ratio.

In terms of useful audio output of a system, we may determine the minimum signal required by reference to Fig. 7. It will be noted that the top curve follows faithfully the normal receiver curve that was shown in the earlier figure, which detailed the characteristics of a fixed gain system without limiting Fig. 4. It also will be noted that the RF input required to maintain this response characteristics is quite large, being between 12 and 18 db above the normal SINAD operating threshold. Minimum performance that can be tolerated is at the sputter point of reception, i.e., where there is a barely perceptible breaking sound in the noise. Considerable improvement in operating range may be obtained at a sacrifice in the S/N performance of the receiver. Minimum marginal audio output of the receiver, that is, where there is a 3 db signal-to-noise ratio, will occur, as a rule, approximately 6 db below threshold.

Information such as this is useful in determining the best audio frequencies to be used for signaling purposes and indicates the reduction in operating range that may have to be accepted to obtain reliability.

In addition to limiting our operating range, we should take into consideration operating techniques that will permit improved performance, such as educating personnel to use normal talking level in preference to overloading the limiter. Also, care should be exercised in the location of the loudspeaker relative to the operator's ear.

Conclusions

In designing systems for optimum intelligibility, we will need to recognize the performance limits that can be set and measure the reliability directly in terms of the intelligibility standard that we set. We should establish reliable methods of measurement whose results can be repeated in order that we may evaluate the long-term performance. If results are to be consistent over a long period, we must take steps to effect this through the means by which we operate the system.

The data we have studied indicates that a minimum use of the deviation limiter is very desirable and that we should seek to obtain maximum efficiency of acoustic output by proper placement of the speaker and confining the output to the speaker cone instead of the speaker case. Every effort should be made to reduce the system noise by installation practices and to recognize the limit of the RF input available to the receiver under the conditions of noise.

In the case of fixed station installations, many steps may be taken to reduce external noise. These include good antenna installations and directional antennas to reduce the aperture through which the noise may be picked up by the antenna, as well as searching out noise sources and reducing the noise at its origin.

There are many other forms of interference that we have not discussed, which will affect the overall performance of the system; however, these require examination of co-channel and adjacent channel systems. These consist of intermodulation due to transmitter congestion, desensitization due to nearby transmitters in the same frequency band, transmitter noise spectrum that exists over a wide band of frequencies up to 1 mc from the offending transmitter, and the problems of adjacent channel modulation splatter which will be experienced as the number of frequency assignments are increased for a given spectrum bandwidth.

It is evident that careful consideration of the factors that we have discussed will pay large dividends in improved performance due to a greater degree of intelligibility of the received signals under all conditions. ★ ★ ★

P 624.

What You Should Know to Design a Compressor Foundation

The designer must consider:

1. ***Behavior of soil under static and vibrational loads***
2. ***Magnitude and effects of soil distortions***
3. ***Means of limiting vibration***
4. ***Possibilities of deterioration or distortion of the foundation***

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Consulting Engineer
Stone & Webster Engineering Corporation

OVER THE YEARS a number of rough rules of thumb have been developed and used for designing compressor foundations. It is perhaps time that the theories of soil mechanics that establish the behavior and distortions of soil under static and vibrational loads, and studies on deterioration and distortion of concrete, be summarized in the hope that a more rational basis for the design of compressor foundations may be evolved.

Foundations for compressors must perform several functions. Among these are:

Support the machine without distortion, which could cause damage by cracking or misalignment.

Limit settlements to acceptable amounts in order to prevent damage to piping or structures.

Limit vibration to acceptable amounts.

While it is customary to think of the foundation in terms of the structural mat or support that is constructed for the machine, the soil upon which this rests is equally important and frequently more difficult to deal with.

Soil Classification

Soils may be classified into two large groups. The first group is composed of the noncohesive materials. These generally have a single grain structure in which the individual soil grains are in direct contact with each other. Typical of this class are sands and gravels having the general structural arrangement shown in Fig. 1. This second group is made up of the cohesive soils, which usually have complex structures. These may be of either sedimentary origin or result from long weathering of the present material. When of sedimentary origin their structures show flocculation of the soil particles into loose honeycombs during deposition. This flocculent or honeycomb structure is typical of that found in many clays.

Graphically illustrating the differences in these structures is the range in porosity found in different soils. The percentage of pore volume in sands usually ranges from about 30 percent for very dense to about 45 percent for very loose sands. Pore space in cohesive soils may range from below 20 percent to as much as 95 percent, i.e., soils in which only 5 percent of the mass is solids.

Single-grain-structure soils may range from very dense soils, in which the individual sand grains or gravel are tightly packed together, to quite loose structures with relatively large voids formed by arching of the grains. Settlement of a load imposed upon a dense sand structure results almost entirely from elastic distortion of the soil grains. This is small and consequently settlements of foundations on dense sand are small. With loose sand, the shearing forces and distortions caused by a load destroy some of the arches, permitting volume change in the soil mass, and, consequently, the settlements of foundations on loose sands are several times those of dense sands.

Vibration and Soil Settlement

Vibration is even more effective in breaking down the soil arches of loose sand than are static loads, and loose sands, when subject to vibrations such as those created by compressors, can settle materially. Fig. 2 shows the observed settlements of a large compressor plant, Plant 1, founded on fine, loose sand. This plant, located in California and consisting of 10 units, serves a large transcontinental gas line. Groundwater level is within about 5 ft of the surface. Vibration from the compressors could be felt as much as 300 ft away. As indicated by the slope of the settlement curve, this plant is approaching equilibrium, about seven years after construction.

Logically, the designer, in studying a new site, must evaluate both the probability of troublesome settlement from compaction of sand by vibration and what corrective or preventive measures are feasible.

Sands in nature generally range from medium loose to

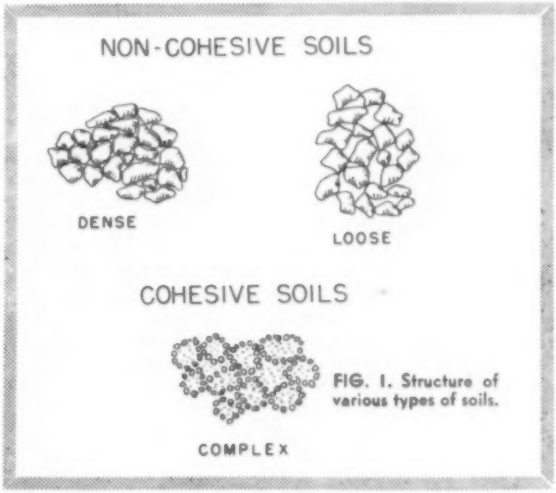

FIG. 1. Structure of various types of soils.

Presented before The American Society of Mechanical Engineers, Annual Meeting, New York, New York, under the title "On the Art of Designing Compressor Foundations."

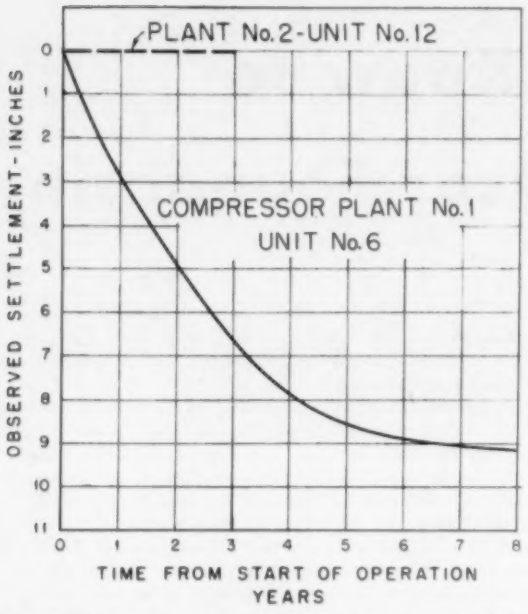

FIG. 2. Settlements of compressor plants founded on sand, plant No. 1 on loose sand, plant No. 2 on compacted sand.

medium dense, and almost any natural sand will be compacted by vibration. Further, since in most formations there are variations in density, this settlement will not be uniform. The magnitude of settlement and, to some extent, its rate will be determined by its initial density. Dense sands will settle much less and much more slowly than will loose sands.

Another factor in the rate of settlement of sand under vibration is the relationship between the foundation and the ground-water level. Sands far above ground-water level generally have films of moisture surrounding the individual grains which develop surface tension at points of contact between grains. The forces developed by surface tension are small, but the weight of any individual sand grain also is small and, usually, these forces are capable of holding the grains in position, which greatly reduces movement under vibration. Sands in which surface tension is absent may be subject to rapid volume change with vibration. Such conditions include sand masses near or below ground-water level where the pore spaces are filled completely with water and sands that are almost completely dry as, for example, the blow sands of desert regions.

Penetration Test

The most commonly employed method of initial investigation of foundation conditions is the dry-sample boring. In these, the number of blows of a 140-lb weight required to drive the sampling spoon 12 in. is most commonly used as a measure of the density and strength of the soils in place. Generally, sands that require fewer than 15 blows in this so-called standard penetration test are considered to be in a loose condition. Sands requiring more than 15 blows are usually sufficiently dense to prevent excessive settlement from vibration. Looser sands require caution and the loosest materials may require protective measures.

In using this criterion, however, caution is desirable. The penetration test is dependable only when used with care on the part of the driller to ensure a square, fair blow. Also, even small amounts of gravel can cause misleading results. Extremely loose deposits of gravel or sand and gravel are not common. Possibly the high velocities of water from which gravels are deposited result in compaction of gravel masses. Occasionally, however, very loose gravel deposits may be encountered.

Evidence, such as pile driving in the area or experience with other structures, especially where vibration is common, always should be gathered, if possible, as a guide to evaluating the foundation conditions.

Compacting

Loose deposits of granular soil can be compacted prior to construction. The two methods most commonly used are vibroflotation and pile driving. Vibroflotation is a patented method. A large vibrator, rather similar in basic principles to a concrete vibrator, is inserted in the soil mass. At the same time, water jets located at the top and bottom of the vibrator flood the mass of soil being compacted. With this method, it is generally necessary to add additional sand as the work progresses to compensate for the reduction in volume of the soil mass.

Piles of wood, concrete or sand have been used successfully both in this country and abroad. In constructing sand piles, a casing is driven into the ground, filled with sand and then the casing is withdrawn. The vibration from driving the pile and the displacement from the added mass of sand effectively compacts the soil.

This method was used to compact the soil underlying a second compressor plant, Plant 2, located on the same site as the compressor plant referred to previously. On this site sand piles having a 16-in. diam were driven on a 4 by 5-ft spacing over the area of the proposed compressor building and to a distance of about 20 ft on either side. These piles varied in length from about 25 to 40 ft, because at these depths a denser stratum was encountered. The total volume of material added within the area of compaction was the equivalent of nearly 2 ft of soil if spread over the surface. Yet, despite this, the surface of the ground settled as much as 6 in.

Settlement records of Plant 2, Fig. 2, show no significant settlement in the first 18 months of operation of the compressor plant erected over this compacted soil mass.

Clay Soils

Vibration has little effect upon clay soils but trouble with these soils may originate from other causes. As previously described, clay soils generally have a loose, honeycomb or flocculent structure. Individual particles of a true clay soil are extremely small, as are the pore spaces between them. When the surface of such soil is loaded, the structure of the soil will readjust to a denser state, squeezing and distorting the individual pore spaces. This distortion, however, can occur only as fast as the water contained within the pores is squeezed out. Because of their extremely fine-grained

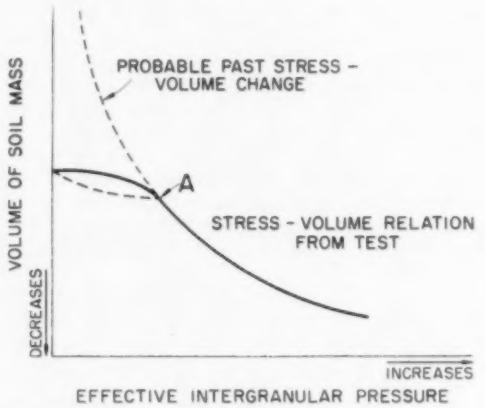

FIG. 3. Typical stress-volume relations for clay soils.

character, clays are of low permeability and this process is slow. Actually, many clays are much less permeable than good concrete. Consequently, structures founded on clay are subject to long-term settlements. The magnitude of settlement is dependent primarily upon the load imposed and upon the previous stress history of the material.

Fig. 3 shows a typical stress-volume curve for clay soils. It may be noted that for loads less than the amount to which it has previously been loaded, point A on the curve, the distortion of the soil is small. Once this so-called preconsolidation load is exceeded, however, the rate of settlement under additional loads becomes several times larger, usually the rate being about 3 to 5 times greater. Preconsolidation of clays to values materially in excess of the weight of the existing overburden is common. At some locations overlying deposits, which have existed once, may have been eroded. In the northern portion of the country the ice of the continental glaciers may have overridden the area. More commonly, preconsolidation is caused by drying. The hardening and stiffening of clay as it dries, which is a familiar phenomenon, can preconsolidate clay soils effectively throughout the depth to which drying extends.

For initial investigation, the standard penetration test may be used for judging whether a clay soil is so soft that excessive settlement should be anticipated. For the average compressor plant, soils requiring less than about 6 blows per ft of penetration should be considered questionable. Additional information may be derived by comparing the natural moisture contents of the soil with the Atterberg limits.[1] To depths of 50 ft or more, soils that have been consolidated only by the existing over-burden generally will have moisture contents slightly below the liquid limit. Soils that have been preconsolidated will have moisture contents significantly lower than the liquid limit and, frequently, approaching the plastic limit. Considerable settlement usually will occur if foundations are placed on soils with moisture contents above or near the liquid limit.

Pile Foundations

The most common method of avoiding settlements under these conditions is to carry foundations through the compressible strata to more stable underlying soils. Piles are most commonly used for this. The use of so-called friction piles, which are merely driven into a clay bed of uniform consistency, has little to recommend it. When, however, piles can reach appreciably stiffer soils, or when they can reach firm sands, they form an excellent foundation. The basis principles of pile foundations are well known, and a number of good references, for example Chellis,[2] are available.

There are certain problems pertaining to compressor foundations that should be mentioned, however. We consider it preferable to use batter piles. These should be arranged in pairs opposing each other in a symmetrical arrangement, and a minimum of four is required for any compressor foundation. Additional batter piles should be used for large compressors.

As most compressors develop rather substantial horizontal couples, these batter piles should be arranged to prevent intersection of the line of action near the center of gravity of the foundation. Otherwise, a rotational motion will develop. This motion occasionally is of appreciable magnitude and this may be quite annoying.

Tops of wood or steel piles should be carried at least 18 in. into the compressor mat. Concrete piles should be reinforced and the reinforcement extended into the compressor mat a sufficient distance to provide anchorage.

Occasionally, development of sites underlain by soft clay will require the placement of substantial quantities of fill. Since the clay will be consolidated, i.e., compressed under the weight of this fill, the batter piles would be bent as shown

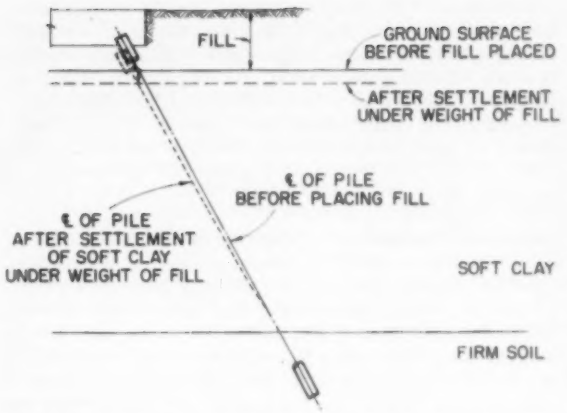

FIG. 4. Distortion of batter piles in soft clay resulting from compression of clay by fill.

in Fig. 4. Batter piles driven through soft clays heavily loaded by fill in this manner may be subject to excessive bending as the clay consolidates, breaking them free of the compressor mat or breaking the piles.

Batter piles should be omitted on sites underlaid by soft soils that are to be or have recently been filled. The additional vibration of the compressor foundation, which will result from omitting the batter piles, may be accepted or the mass of the compressor foundation increased to reduce the vibration.

In designing foundations under these conditions, it should be noted that the vertical piles, although not subject to these excessive bending stresses, will be loaded additionally by the consolidating clay soil in which they will be embedded since this soil will tend to hang up on the piles. This problem of negative friction must be given consideration in establishing pile loads and total number of piles to be installed.[1,2]

Resonant Frequency Problem

Vibration of compressors and their foundations is always annoying when excessive and occasionally troublesome as it adds to maintenance and repair problems. It has been studied extensively over a great many years and the further these studies extend the more complex it becomes. There is for any given system of soil, compressor, foundation, and direction of exciting force to resonant frequency, that is, a frequency that will excite maximum amplitudes of vibration. In addition to this maximum response, excitation of this resonant frequency also will cause the maximum rate of settlement and, probably, maximum total settlement for compressors placed on sand. This resonant frequency is not constant and is not a function solely of the soil. It will change with time depending upon variations in groundwater level and will increase as the soil compacts. Present studies[3,4] based on constant soil conditions indicate that the frequency of a given superimposed mass-soil system will:

1. Decrease with increasing mass of the foundation.
2. Decrease with increasing size of the loaded area.
3. Decrease with increasing unit soil pressure.
4. Decrease as the unbalanced force is increased.
5. Increase or decrease depending upon the shape of the loaded area.
6. Increase or decrease depending upon the distribution of contact pressure between the structural foundation and the soil. (Generally, it will be found that concentrating the loading at the outside edges of the footing will give higher frequencies and lower amplitudes of vibration.)

Most investigations of foundation resonance have been directed toward vertical oscillations. Horizontal motions

and rotational movements also can be excited. At the present time, there is no practical method of analyzing a compressor-soil system during its design stages to determine whether resonant vibration may occur. Although a few cases of resonant vibration have been reported in the literature, it seems to be a rather uncommon problem, which perhaps should be handled by corrective measures when it does develop, rather than by spending substantial sums on initial investigations.

Determining Mass of Compressor Foundation

In the absence of sound, theoretical means of analysis, a number of rules of thumb for establishing the mass of a compressor foundation have been developed. Many of these relate the total mass of the foundation to the mass of the compressor. Others relate the mass of the foundation to the mass of the moving parts. Making the foundation three to four times as heavy as the compressor or 15 to 20 times the weight of the moving parts is common practice. A method of analysis, which has been used by the writer's office for some years with generally good results, may be developed as follows:

It is assumed the disturbing force varies as a simple harmonic function. Then:

$$F \sin \omega t = Ma$$

letting:

$$M = \frac{KW}{g} \text{ and } \omega = \frac{2\pi\,(\text{rpm})}{60}$$

integrating twice with respect to time and letting:

$$\dot{x} = 0 \text{ at } t = 0$$
$$x = 0 \text{ at } t = 0$$

then:

$$x = \frac{gF \sin \omega t}{\omega^2 KW}$$

and:

$$x_{max} = \frac{91Fg}{(\text{rpm})^2 KW}$$

in which:

F = maximum value of disturbing force, lb
rpm = frequency of disturbing force, cycles per min
W = weight of machine and foundation, lb
K = a constant depending upon soil conditions. (It is assumed K = bearing value of soil expressed in kips per square foot. For pile foundations K is taken as 1.0.)
g = acceleration due to gravity = 386 in./sec²
x_{max} = maximum displacement of machine from static position, in.

In using this method of analysis, the foundation weight necessary to limit the displacement of 0.005 in. is usually selected. The method may be used to determine translational motion from either the primary vertical or horizontal force, whichever is larger. Generally, for multicylinder units if these are satisfied, motion from secondary and torsional forces will be within acceptable limits. However, a similar expression can be developed for determining the rotational movement that may occur with couples if these are exceptionally large or if rocking from horizontal primary forces might be troublesome.

This expression is not theoretically correct because the method of analysis and the constants selected are quite arbitrary. However, it allows for the effects of strong, stable soils in reducing movement and for the improvements that may be made by balancing machines to limit the unbalanced forces.

Balancing Compressors

Multicylinder compressors can be balanced to minimize particularly objectionable unbalanced forces. Fig. 5 shows schematically a compressor with the various unbalanced forces that may be present. The bar graphs show for one specific type of compressor the relative magnitude of these various unbalanced forces for different systems of crank weights.

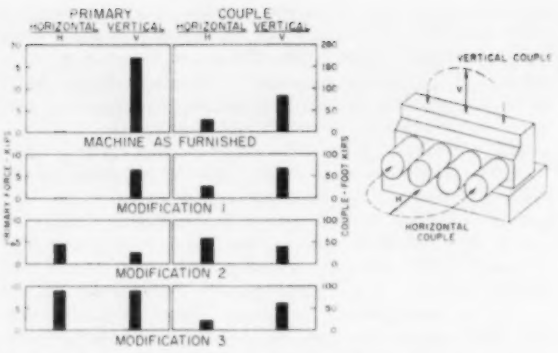

FIG. 5. Typical diagrams of unbalanced forces acting upon compressors.

Of these forces, the primary vertical and primary horizontal forces usually are the most troublesome. Primary vertical unbalanced forces cause vertical oscillation of the machine and its foundation. Primary horizontal unbalanced and primary vertical couples cause rocking of the compressor and its mat.

The magnitude of rocking motion will vary inversely with the moment of inertia of the compressor and its foundation, and directly with increasing variations in soil pressure at the outside edges of the foundation. For constant total weight, the moment of inertia of the compressor mat varies approximately as the square of the width of the mat. Also, variations in soil pressure at the edges will vary inversely with the square of the width. Consequently, the wider the foundation mat the less the compressor will rock.

Arranging multi-compressor installations on a continuous foundation mat with their crankshafts normal to the length of the mat will result in minimum vibration from horizontal inbalance. Advantage can be taken of the great stiffness of such a continuous compressor mat in resisting horizontal rocking to rebalance machines for minimum primary vertical inbalance. The width of the combined mat will prevent significant vibration from the increased horizontal inbalance.

Using these principles, it is possible to design for minimum overall vibration with minimum total mass in the foundation. In designing any compressor installation, careful consideration should be given to the general principles outlined of arranging and balancing the units to obtain minimum vibrational amplitudes at maximum economy.

Structural Foundation Considerations

Discussion this far has centered around deformations and movements of the soil that support the compressor plant. Distortions of the structural foundation upon which the machines are mounted occasionally can be troublesome as well.

Most compressor foundations are constructed of concrete. Usually it will be found that requirements of mass will result in foundations of such thickness and overall shape that the unit stresses are below normally accepted design stresses. At these low unit stresses, elastic deflections usually will be within acceptable tolerances.

Concrete shrinkage. Concrete shrinks when drying. A foundation subjected to excessive drying at its upper surface, while the bottom is kept damp by soil, may warp severely. Long or extremely wide foundations should be

checked for warping, especially if site and climatic conditions are adverse. Concrete also is subject to deterioration from a number of causes. Freezing and thawing, impurities in mixing water or in the aggregates, unsound aggregates, and, particularly in the southwest, attack by sulfate ground waters are rather common occurrences.

Alkali-aggregate deterioration. A more serious type of deterioration, the cause of which has only been determined in the past few years, is alkali-aggregate reaction. Deterioration results from the reaction of finely divided or amorphous silica with free alkali in the cement. These constituents react chemically to form complex silicates, which develop high osmotic pressures, thereby disrupting the concrete mass by internal pressure. The outward expression of this deterioration is generally a random cracking pattern. The structure moves and cracks as if it were swelling from the inside. This is precisely the case. The internal growth may be large. Increases of ½ percent or more have been recorded. Thus, a compressor foundation about 30 ft across, suffering from these difficulties, could grow as much as 2 or 3 in. The growth is frequently attended by cracking, distortion, and, occasionally, destruction of machinery that is mounted on or in the concrete mass.

Trouble from internal growth has developed in a number of hydroelectric projects throughout the United States and, in several cases known to the writer, in compressor plants. Reactive aggregates include many of the siliceous rocks, which have in the past been considered desirable concrete aggregates. Among these are glassy or cryptocrystalline rhyolites, dacites, and andesites as well as certain sandstones, phylites, and siliceous limestones.[5] To date, the best method of prevention is to use aggregates known to be innocuous. Experience, however, has indicated that no case of deleteious reaction has occurred in any important structure where the alkali content of the cement was kept at less than 0.6 percent, although in several of these structures highly reactive aggregates were used. Low-alkali cement should be used whenever a questionable or known reactive aggregate must be used. In the laboratory, deleterious reactions have occurred between reactive aggregates and cements containing as little as 0.2 percent of free alkali. Consequently, at this date, it is uncertain whether this commonly applied 0.6 percent limitation on free alkali will assure complete freedom from trouble with reactive aggregates.

Testing for reactivity. Reactivity of aggregates can be tested by several different methods. In the most accurate test, mortar bars are made of the suspected aggregate and a high-alkali cement. These are stored under carefully controlled moisture conditions and observed for a period of 6 months or a year. Reactive aggregates under this test always will show excessive growth. This, of course, is a relatively long-term test and is cumbersome and rarely used except on major projects.

A short-time chemical test has been devised and is commonly accepted, although its discrimination and accuracy are probably not as high as the mortar-bar test. This test, ASTM C227, affords a quick check of the reactivity of aggregates and should be included with the common physical tests in selecting aggregates.

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Cherokee Line Runs Into Mud at Jenks, Oklahoma

LAYING A PIPELINE through hilly country can be rugged work. When spring rains turn the earth into sticky mud pipelining gets really tough.

The contractors for the Cherokee Pipe Line from Tulsa to Ponca City, Oklahoma, ran into these conditions at Jenks, Oklahoma. Heavy rains bogged operations a bit but the line made good progress.

Pipeline Service Company of Seminole, Oklahoma, was laying a 12¾-in. OD line for Cherokee Pipe Line Company to carry products from the Continental Oil Company and the Cities Service Oil Company refineries at Ponca City. The line is approximately 85 miles in length. It connects with the Glenpool station at Jenks.

The Cherokee Pipe Line Company is owned jointly by Cities Service Pipe Line Company and Continental Oil Company. The products division is operated by Continental Pipe Line Company, who supervised the construction of the line.

Twenty-two miles of Jones & Laughlin Steel Corporation's electricweld line pipe was used in the section beginning at Jenks. The pipe was manufactured at the Aliquippa, Pennsylvania Works near Pittsburgh, and was shipped by barge to West Memphis, Arkansas. Stone Trucking Company of Tulsa transported the pipe from West Memphis, Arkansas, to the pipeline right-of-way.

Coating and wrapping on the Cherokee line was handled by Secrest Pipe Coating Company of Tulsa, Oklahoma.

Coating and wrapping Cherokee's line near Jenks, Oklahoma.

How to Cut Design Hours to Computer Seconds

Complete calculations for one segment or station average 1.4 seconds with electronic computing equipment

REDUCING MAN-HOURS to computer-seconds has become a reality for pipeline designers, due to the installation of electronic computing systems by many companies.

In natural gas pipeline design, electronic computations for one segment of pipe or one compressor station can be completed in slightly over one second.

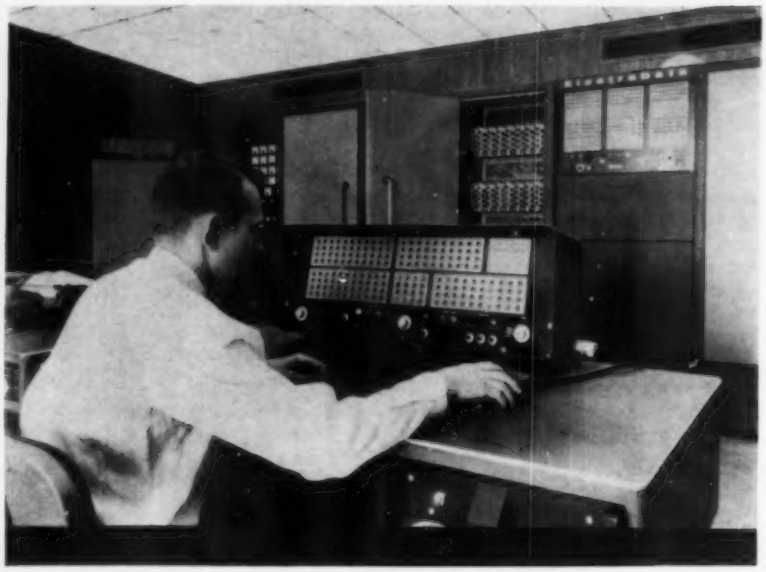
Manual calculations, time-consuming and less accurate, are eliminated in the determination of stresses and strains in critical bends and of pressure drop areas and horsepower required for a gas-accumulation system. These tasks can be particularly lengthy and complicated for slide-rule solution.

The uses of digital computers such as the medium-size Datatron are not limited to pipeline design, of course. Refineries and their research centers are using Datatron for mathematical model refinery operation, simulated experiments, data reduction, and other problems. These jobs lead to the improvement of catalytic cracking processes, octane and vapor pressure blending, reforming, alkylation, tetraethyl lead addition, equipment design, geophysical properties, hydrocarbon separation, and quality control.

Other operations include meter measurement, civil engineering, estimating, inventory control, production control, payroll processing, and accounting.

Datatron is the electronic data processing system manufactured by the ElectroData Division of Burroughs Corporation, at its 250,000-sq ft plant in Pasadena, California.

For data on an initial segment of pipe or a compressor station, Datatron calculates the outlet pressure, prints out the resulting answer, and automatically proceeds to the next segment or station. The computer clicks off the entire pipeline in this manner, figuring the pressures at designated points along the system.



Electronic data processing system in operation. Operator is seated at control console, hand on manual input keyboard. Central computer is in background, at right.

The engineer is relieved of tedious calculations needed when changes occur in the system's load. He also is provided with the means to quickly change existing pipeline specifications.

Units required in the data processing system for pipeline design include the central computer, paper-tape punch, photoelectric reader for information input, electric typewriter and line printer, floating point arithmetical unit, and magnetic tape file and control.

First Step

The storing of information needed to lay out a natural gas pipeline is the initial step in the designing project. Data on existing specifications are punched onto paper-tape. Using a photoelectric reader, this information is read into the central computer and immediately transferred to magnetic tape storage locations. The data are stored as individual blocks of information, available for call by the computer at any time. Each of these blocks contains the information on a single segment of pipeline or a single compressor station.

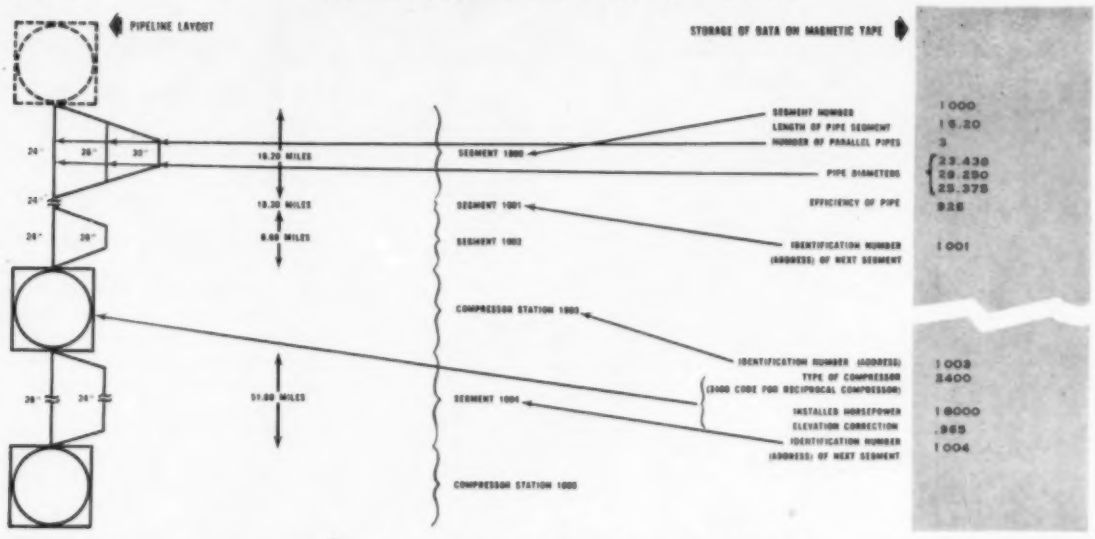
A segment is a section of pipeline where the number of parallel pipes, the inside diameters and the efficiency do not change. To facilitate locating the data on magnetic tape, an individual identification number called an "address" is assigned to each block of information. This identifies for the computer the information block of a specific segment of pipe or a station.

When not in use, pipeline data are easily removed from the computer system and stored on magnetic tape. Data processing instructions are entered into the computer by means of punched cards or punched paper-tape. They also may be stored on magnetic tape with the design specifications, and called into the computer before calculating begins. These instructions, called the

This article was prepared by ElectroData Division of Burroughs Corporation.

FIG. 1.

Typical pipeline design problem.



printout of sample problem

This is an illustration of the printout on an electric typewriter of DATATRON's solution to a pipeline design problem. Printouts of four successive trial runs were made, using the specifications of the pipeline shown in Figure I.

The first printout shows a successful trial run of three pipe segments and one compressor station. The resulting calculations indicate that the outlet pressure for each segment and station is satisfactory.

PRINTOUT 1

I.D.	P-1	d	L	Q	P-2
1000	650	23.438	16.20	800000	619
		29.250			
		25.375			
1001	619	23.438	18.30	800000	503
1002	503	23.438	8.60	800000	439
		25.438			

COMP	1003
cPs	436
IPd	629
r	1.441
HP/MM	21.664
HPi	18000
Q	800000

An increase in volume of gas of 50,000 MCF was made. As a result, outlet pressure dropped below the optimum level

PRINTOUT 2

I.D.	P-1	d	L	Q	P-2
1000	650	23.438	16.20	850000	616
		29.250			
		25.375			
1001	616	23.438	18.30	850000	484
1002	484	23.438	8.60	850000	408
		25.438			

COMP	1003
cPs	405
IPd	570
r	1.405
HP/MM	20.390
HPi	18000
Q	850000

The design engineer added an additional length of parallel pipe to pipe segment 1001 (indicated by plus sign). The significant increase in outlet pressure for both segments 1001 and 1002 indicate the addition of pipe to the original specifications was satisfactory.

PRINTOUT 3

I.D.	P-1	d	L	Q	P-2
1000	650	23.438	16.20	850000	616
		29.250			
		25.375			
1001	616	23.438	18.30	850000	532
		+29.250			
1002	532	23.438	8.60	850000	464
		25.438			

COMP	1003
cPs	461
IPd	648
r	1.405
HP/MM	20.390
HPi	18000
Q	850000

As an alternate method for increasing outlet pressure, 2000 horsepower was added to the compressor station in this trial run. This additional horsepower raised the outlet pressure value to a satisfactory reading.

PRINTOUT 4

I.D.	P-1	d	L	Q	P-2
1000	650	23.438	16.20	850000	616
		29.250			
		25.375			
1001	616	23.438	18.30	850000	484
1002	484	23.438	8.60	850000	408
		25.438			

COMP	1003
cPs	405
IPd	597
r	1.470
HP/MM	22.690
HPi	18000
Q	850000

+2000

Processing flow chart, showing computer treatment of pipeline design problem.

"program," provide orders that direct computational operations.

Reading

The computer begins its internal computing operations when the address and inlet pressure and volume of gas for the initial pipe segment are read into it by a manual keyboard. Once fed this data, the system automatically:

1. Locates the required data on magnetic tape.

2. Places the information on the computer's 40,800-digit magnetic storage drum.

3. Determines logically whether the data obtained pertains to a pipe segment, reciprocal or centrifugal compressor, and selects the appropriate method of calculation.

4. Calculates the outlet pressure by standard equations.

5. Activates an electric typewriter or line printer to print out the resulting data.

The print-out on each pipeline segment includes an identification number, inlet pressure, inside diameter of each pipe, length of pipe, volume of gas, outlet pressure, and intermediate results. For each reciprocal compressor station, the answer includes identification, inlet pressure, outlet pressure, compression ratio, horsepower per million cubic feet of gas, horsepower installed, and the volume of gas. The same print-out is obtained for the centrifugal compressor, plus data on the temperature of the gas.

When calculations for one segment are completed, the data for the next segment are automatically transferred into the computer from magnetic tape. There is no need to manually insert pressure and volume data before processing each segment or station. The computer continues repeating its computing cycle for each segment or station until pressures for the entire pipeline have been calculated and results printed.

Complete calculations for one segment or station average 1.4 seconds. Some 42 segments and/or stations can be calculated in one minute.

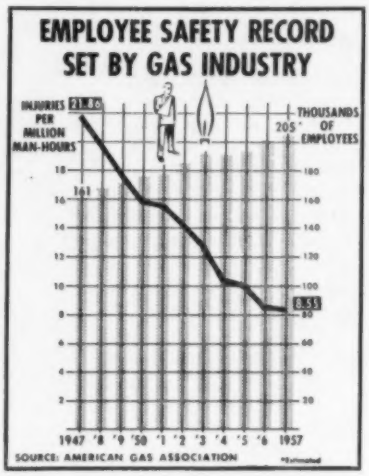
Design changes to existing pipelines are handled quickly by the computer. Pressure-volume computations are made and the altered data is written over the original information, thereby updating the design.

Another advantage of electronic pipeline computing is its value as a management tool. Top management may obtain immediate answers necessary in arriving at decisions pertaining to the adequacy of present systems, need and cost of expansion, new construction, and cost-cutting routines. ★

Pipeline Safety Record Best In History

THE SAFETY RECORD set by pipeline and gas utility companies during 1957 was the best in the industry's history, the American Gas Association says in summarizing the annual report of its Accident Prevention Committee. AGA notes that 1957 was the tenth consecutive year in which the safety record has been improved.

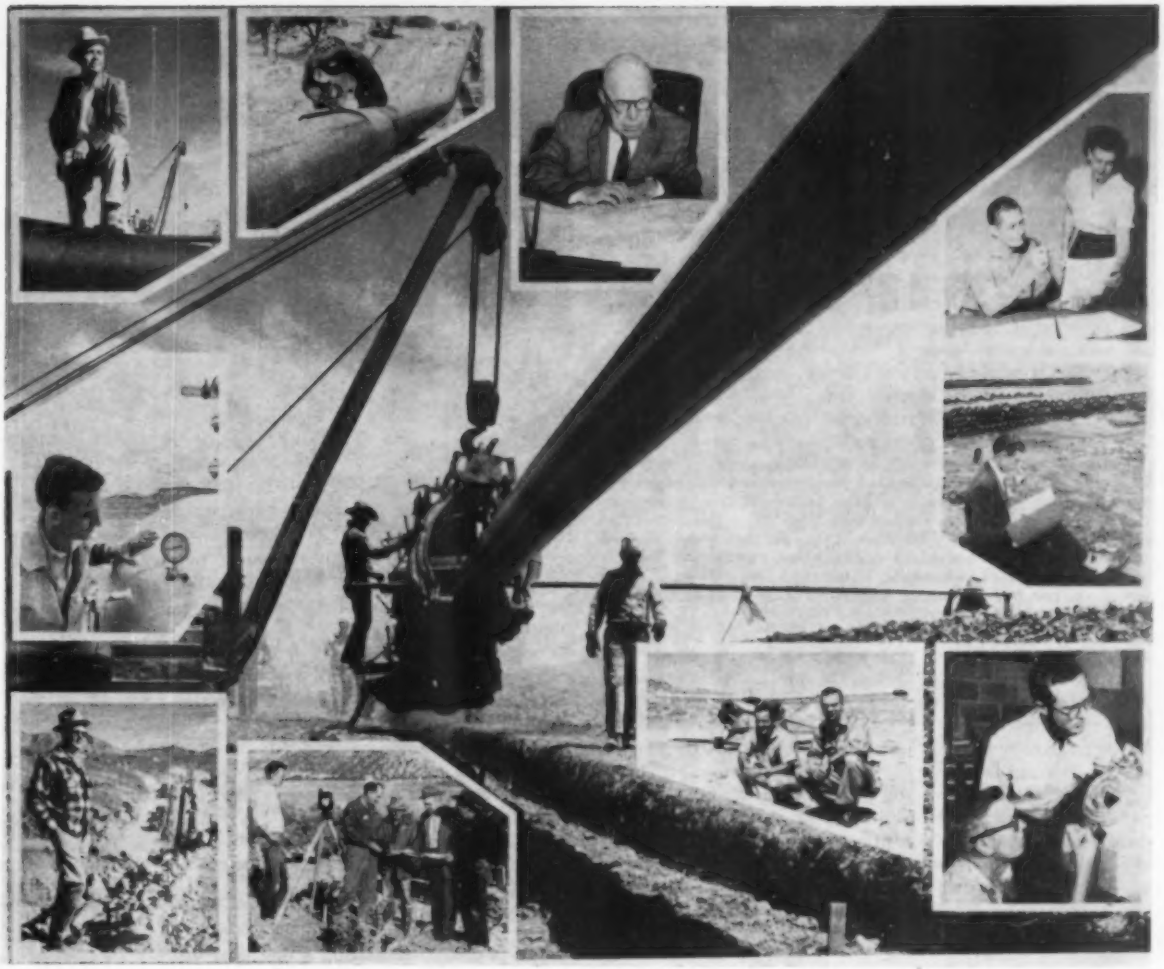
An all-time low figure of 8.55 disabling injuries per million man-hours



While the gas utility and pipeline industry's total employment has increased 27 percent since 1947, the safety record of the industry has been improved 61 percent. The accident frequency rate was reduced in 1957 for the tenth straight year, achieving an all-time record low of 8.55 disabling injuries per million man-hours worked.

was established last year, compared with the post-war peak of 21.86 in 1947 and the best previous record of 8.68 achieved in 1956. The association's report is based on returns from 434 companies representing more than 95 percent of the industry's total of approximately 205,000 employees.

Pipeline and gas utility companies also registered a new low in terms of accident severity. The severity rate (the number of days charged to disabling injuries per million man-hours worked) dropped from 652 in 1956 to 447 last year. The peak year of severity was 1957 when the rate was 1277, more than double last year's record.



These Are the People Who Build a Pipeline

MEN, MACHINES, AND MANY JOBS build a pipeline. One of the newest continuous sticks of pipes and pumps to deliver crude oil in our country has just been completed. The Four Corners Pipe Line, originating near Farmington, New Mexico, and terminating near Los Angeles, California, was built over a period of approximately 10 months.

Some, but far from all, of the representative jobs necessary in such a project are depicted in the accompanying photograph, beginning top center-clockwise. The **president** is charged with the administrative duties of satisfying the owners of the pipeline and delegating authority to those responsible for its construction. **Right-of-way man** and his staff procure right-of-way over route mapped by the surveyors to best interest of land owners and the project. **Material man** is responsible for purchasing pipe and all other materials and having it delivered to strategic locations along the right-of-way. **Archaeologists,** working for government agencies, follow construction through unexplored areas in search of new archaeological facts. **Pilots** serve both management and construction personnel by flying "bush pilot" trips to remote areas along the right-of-way.

Surveyors and **guides,** the first in the field, map out the route of the new pipeline. **Contractors** submit bids, and on acceptance, perform the actual construction of the pipeline according to specifications. **Design engineers** prepare specifications for equipment suitable to transport the type of crude oil produced over the designated terrain. **Inspectors** are men of long and varied experience in pipeline construction that perform liaison duties between management and contractors to assure the best and most economical construction. **Welders** — only those passing the most rigid tests — are used to weld the 40-ft lengths of pipe together.

The center picture shows a typical coating and wrapping operation on this 650-mile pipeline built and now operated by Shell Pipe Line Corporation.

The Four Corners Pipe Line is delivering 70,000 bbl of oil daily to the Los Angeles area. It is owned by Continental Pipe Line Company, Gulf Oil Corporation, Richfield Oil Corporation, Shell Oil Company, Standard Oil Company of California, and The Superior Oil Company. ★ ★ ★

Pipeline Fundamentals

PIPELINE WELDING

Part 4. Training the Welder

Editor's Note: The technique of welding has become more exacting as a result of the higher pressures at which pipelines are operated, new methods of pipe forming, and changes in the chemistry of steel. United Gas Pipe Line Company has established a procedure of training to assure a high degree of proficiency in its welders and welding inspectors. We are indebted to UGPL and that company's magazine, *United Gas Log*, for permission to include in our "Fundamentals" series this discussion outlining its methods.

WELDING of pipe joints as an accepted pipeline method is just a little more than three decades old, and in that comparatively short span of time, pipeline welding has kept pace with other notable improvements in pipeline materials and methods.

The technique of welding pipe to form an integral conduit for natural gas transmission has become more and more exacting as pipeline pressures have increased. New pipeline materials have been developed, and new methods are being used to form pipe in order to keep abreast of internal pressure requirements. Welding, of necessity, has had to keep pace with these developments.

In pipe fabricating shops, and in special instances, various welding processes are now employed. However, except for small pipe — 2-in. and smaller — all steel pipe on pipeline work is welded with manual arc welding. Oxy-acetyene welding is employed for small pipe.

Improved methods of examination, inspection, and testing have resulted in more clearly defined limits of acceptance of welding. Procedures set up by the ASME Boiler Code, the API Code and the ASA Piping Code for Minimum Standards are the basis for procedures that have been incorporated into United Gas Pipe Line Company's own specifications; however, our engineering department through extensive research has developed the qualifying procedure now in effect in our welding specifications for pipeline and plant installation.

HOW THE WELDER IS TESTED

Each welder is approved for construction work only after an examination of his welding ability. The test consists of making one or more welds, depending on the nature of the work he is expected to do, and it is witnessed by a company welding inspector who reports on the technique as well as the strength of the test welds. If, in the inspector's opinion, the welder's technique is unsatisfactory, there is no need to go further with the examination, for considerable time and expense are involved in the tests.

Generally, for pipeline work, each welder's test requires him to make a weld of two pieces of pipe secured in a horizontal position, simulating a bell hole weld. Pipe selected for test is of the same material as that of the line to be constructed, but not necessarily of the same size; thickness of the test pipe is representative of the thickness of the line pipe.

Welders qualified on one kind of pipe may be re-tested for another kind. That is, although he qualifies on a low

Left — Welder begins the horizontal butt weld test by working "down hill" to apply the stringer bead. Center — He then reverses direction to "up hill" on the second or hot pass. Right — Brushing out the weld between passes.

Acceptance of a test weld is on a basis of both visual and physical inspection. Here, instructors observe progress and technique of welder making one of several passes on the horizontal test.

yield stress pipe, he would be re-tested for welding on high yield stress pipe. For welders assigned to other than pipeline welding, additional tests are required, conforming with the type of work to be done.

Because of the variety of pipe welding, and because of the temperatures and vibration to which much of our station gas piping is subjected, each welder qualified for such work is required to make three test welds: (1) That of two pieces of pipe secured in horizontal position, again simulating a bell hole weld; (2) that of two pieces of pipe fixed, end to end, in vertical position, and (3) a weld made to form a "T" junction of two pieces of pipe, commonly known as a branch connection. In the third test weld, one piece of pipe, the branch, is welded into the side of the second piece called the "run" or "main." Material and thickness of the pipe again are selected to be representative of pipe to be used in the installation.

United Gas Pipe Line Company welders have been satisfactorily welding on our pipelines for many, many years. Still, because of the demands of the job in his particular locality, many a welder has been unable to keep up with all the new techniques and the various methods of testing welds. Unless he has been used as a welding inspector, he has not had full opportunity of learning what to look for in a faulty weld.

TRAINING WELDERS AS INSPECTORS

Continued expansion of our pipeline system requires calling on United Gas welders to serve as pipeline inspectors on new construction work, making it not only advisable but essential that our own welders be acquainted with the qualifications required of the contractor's welders.

This program is a cooperative effort by personnel of the general office engineering department and operating departments of the various pipeline districts. It is under the personal supervision of the company's chief welding inspector. The purpose is to train a certain number of district welders by requiring them to make the same qualification test that is required of construction welders. They are instructed in requirements of company welding specifications, which, as explained before, conform to various codes.

In addition, the district welders are instructed in examination of contractor's welders and the required welding techniques. Examination of the test welds are interpreted in terms of acceptance of the work, the examinations being both of the destructive and the non-destructive types.

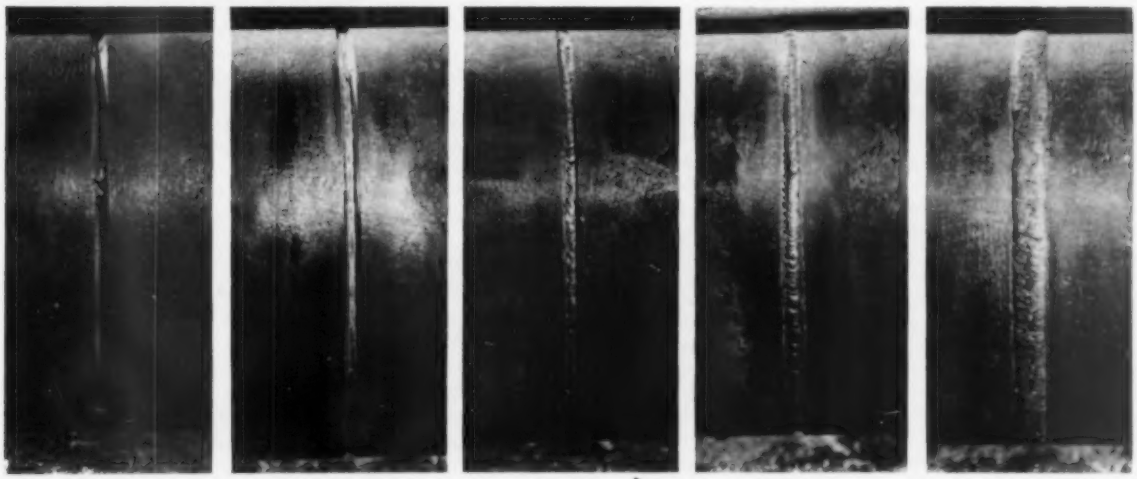
Destructive tests include the pulling of a bar or strap of the weld to determine its tensile strength. It also includes bending the bar to determine ductility of the weld. Soundness of the weld is determined by what is called the "nick break." In this test, the bar or strap is notched at the weld and then bent to failure. Examination of the broken specimen is interpreted in terms of flaws in the weld.

Non-destructive tests are those made without destroying the test weld. Among these are X-ray tests, which utilize equipment similar to that used in X-raying the human body, the gamma-ray tests. The gamma-ray method utilizes a substance such as cesium, tantalum, or cobalt that has been made radioactive.

Rays from the radioactive material are allowed to penetrate the weld and pipe section, leaving its registration on a photographic film similar to the X-ray method. The film in either method is then processed to show difference in its density, indicating flaws that may be present in the weld through interpretation as in any X-ray film. Use of gamma-rays is a slower process, and the definition is not as clear as in the X-ray film; however, it has the advantage of requiring less cumbersome equipment than the X-ray method.

There are other destructive tests like the magnaflux and

WELDING STAGES OF HORIZONTAL TEST.



Tack weld. Stringer bead. Hot pass. Filler pass. Cover pass.

Lining up for vertical weld.

Tack welding.

Beginning stringer bead.

Close-up of completed vertical butt weld.

dye tests, used primarily to determine surface cracks. Still other non-destructive tests have been used, but, as yet, not on a commercial scale for the test of welds.

Acceptance of the test weld is on a basis of both visual inspection during the course of the test and on physical inspection of the actual weld made. For the physical tests, the completed weld is examined either by X-ray or gamma-ray, and then the weld is marked off in strips or "straps."

The straps are then cut from the weld and subjected to tests for tension, bending, and nick breaks. Tensile strength, the stress at which the strap will separate when pulled, must not be less than the tensile strength of the pipe material, the value of which is usually stipulated in the specifications.

In the bend tests, the straps are bent to form a 180-deg bend. No crack or other open defect exceeding ⅛-in. in any one direction is allowed to be present after bending, although cracks occurring on the corners of the specimen are not considered as being reason for non-acceptance.

The nick break test is used to produce failure of the weld so the cross-section of the weld may be examined for flaws. The kind and extent of the flaws that can be present and the weld still be considered acceptable are specifically set up in the company's list of Standards of Acceptability.

WHAT ARE THE COMMON DEFECTS?

Defects of a weld are many in number, though some are much more common than others. Some of the more common flaws are "slag inclusion," "lack of penetration," "gas pockets," "cracks," and "burn throughs."

Slag inclusions are slag-filled voids in a weld. Lack of penetration is, as the term implies, a lack of penetrating to the base of the weldment. Gas pockets are voids in the weldment produced by entrainment of gas in the weld. Cracks are fractures in the weldment or weld area. Burn throughs are craters in the root of the weldment after a portion of the weld and adjacent parent metal has been broken down and dissipated.

Other defects are "stringer bead windows," "slag line," "wagon tracks," "non-fusion," "concave stringer," "internal undercut," "internal bevel," "skip cracks," and "crater cracks." Not only is it necessary to be able to identify all these flaws in the weld, it is also necessary to know how to avoid producing them.

In addition to the defects mentioned, another factor termed "high-low" may lead to failure of a weld. This weakening factor resulting from misalignment is caused by pipe ends being out of round or by either pipe or fittings

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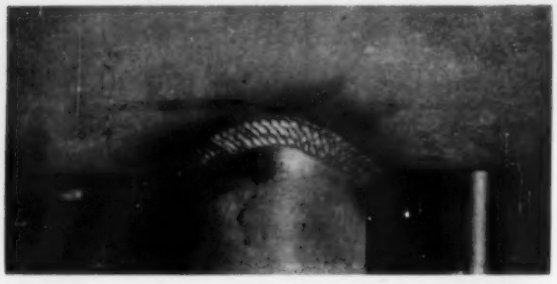
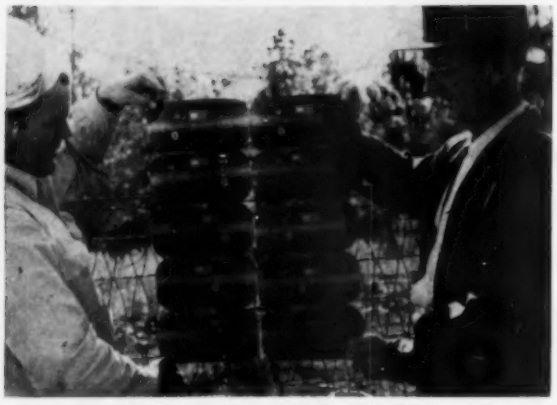
Above — Completing cover pass of a branch connection weld test.

Below — Close-up of the finished weld.





Inspectors examine gamma-ray film for welding flaws following tests.

being warped. Most of the flaws mentioned can, with practice, be detected in the X-ray film. Interpretation of X-ray film thus becomes an important function of the welding inspector.

TEST PROCEDURES

To demonstrate his ability, a welder must make certain welds designed to evaluate his work in various welding positions, using various welding techniques. Sections of pipe to be welded are prepared in advance with joint surfaces to be welded already beveled and prepared to conform with requirements of the test.

In preparation for the test, the welder must adjust his welding machine for the required current outlet so that the proper welding arc is sustained between the welding rod and the pipe metal.

In the fixed horizontal butt weld test, the two pieces of pipe are fixed to the support and then lightly tacked (welded in spots) in three or four places around the circumference of the pipe, but not at the starting or finishing points of the first layer of welds.

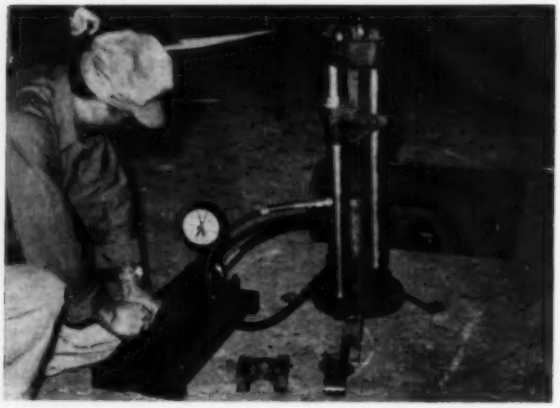
The test welder is then ready to begin. Starting at the top of the pipe, he makes the first "pass," called the stringer bead, to the bottom of the pipe. Beginning again at the top, he then welds down on the other side to complete the stringer bead.

The next layer of weldment, called a "hot pass," is applied by starting at the bottom and working up to the top on both sides. While the stringer bead was made "down hill," the hot pass and succeeding "filler" passes to fill up the joint with the top surface of the pipe are made "up hill." To dress off the weld, a final or "cover pass" is applied, giving the welded section the distinctive bulge above the surface of the pipe.

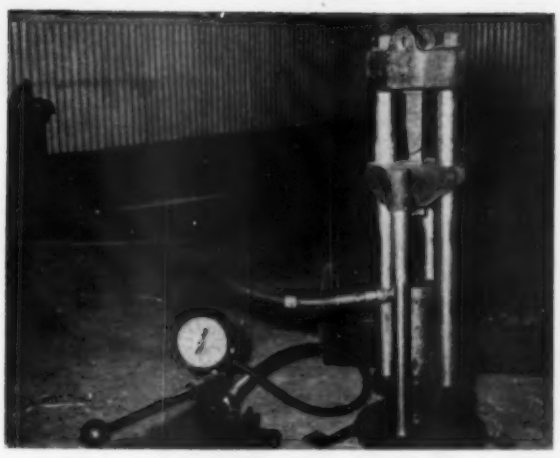
The welding rod used for stringer bead and cover pass is soft and free-flowing, while the rod used for the filler passes is one that conforms with the metal being joined to give the joint proper strength.

In the second test, a fixed vertical butt weld, preparation for welding begins with tacking the two test specimens together with proper spacing. Tack welds are distributed around the surface of the joint so they will not fall within any of the straps or sections of joints to be examined after the weld is completed. Since there is no top or bottom of this joint, the welder starts his stringer bead at any point, welding all around. The hot pass follows, starting at a point so the two starting points do not fall one upon the other. Succeeding passes then are applied, in each case making sure the starting points are varied.

The third test is made with the section of pipe to form the branch on the under side of the pipe main. This means that all the welding is done overhead. Again the two speci-



Left — Marking off "straps" to be subjected to the destructive type of weld testing. Right — A strap under test in the tensile testing machine.



Close-up views of straps under test. Left — Strap has failed under tremendous force applied in tensile test. Right — Illustration of method used in applying the bend tests.

mens are prepared in advance and tacked into position. The welder then starts at any point, as in the second test with the stringer bead, then staggers the starting points of each of the succeeding passes.

SAMPLE TESTING

After completion, the welds are radiographed, either by X-ray or gamma-ray, and the welded samples are marked off so straps can be cut for tensile, bend, and nick break tests. For the tensile test, the strap is secured in the jaws of a tensile testing machine. By means of a hydraulic pump the jaws of the machine can be forced apart, pulling on the strap until the strap fails. A gage, which is part of the machine, indicates the total force applied to the pull on the strap. Knowing the cross-section of the strap, the pressure or force per unit area can be calculated for the value indicated on the gage. Thus, the stress produced by the force applied when failure began to occur is the tensile stress of the metal.

The bend test is made by placing the strap in the bend test jig so that force can be applied to bend the strap into a 180-deg return bend. A second strap is bent with the strap surface to which the force is applied reversed. These straps are then examined for cracks. No crack larger than ⅛-in. is allowed except cracks at the edges of the specimen.

To make the nick break test, the straps are notched along the center line of the weld from each end to a depth of ⅛ in. The sample is then bent until it breaks into two parts through the line of the notches where the strap usually will fail. The cross-section of the failed portion is examined for soundness of the metal and compared with the limits of acceptability.

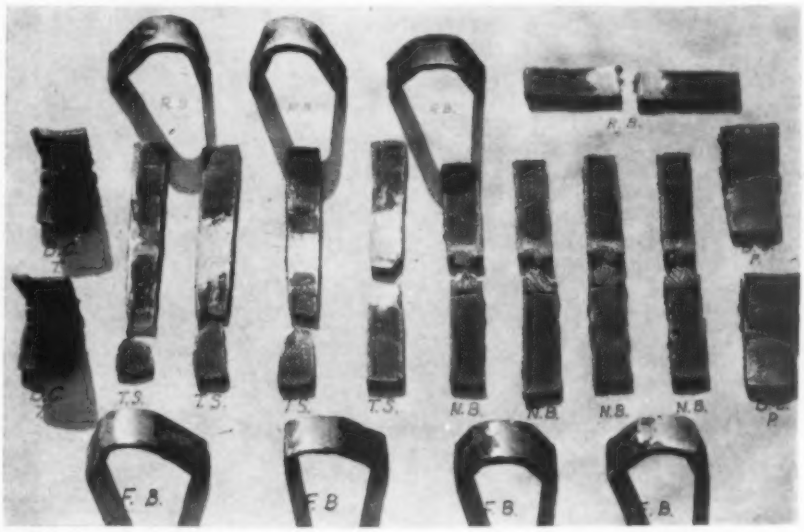
If one of the welds made by a welder on test fails to meet stipulated requirements, the welding inspector may allow the test welder to make a second weld of that portion of the test. However, the inspector must weigh his judgment of the welder's technique in determining whether he is qualified for a re-test.

As may be noted from these tests, each welder qualified has proved his ability to weld up hill, down hill, overhead, and all around the piece of pipe. He has demonstrated his ability to make a sound joint of two pieces of steel pipe using various welding techniques and all positions of welding. Some companies require additional tests, demonstrating ability of welders to make specialized welds such as "hot taps," "Y" connections, and the repair of faulty welds, but the preference of UGPL engineers is for special welding problems to be under the direction of a welding inspector.

Although the destructive tests outlined may indicate that a strong weld has been made, certain defects may be hidden in the parts not tested. To prove the homogeneity and the lack of flaws in a weld, the radiograph gives the best test of the specimen.

As already noted, either X-ray or gamma-ray may be used for the non-destructive tests. Where speed and definition in the film are essential, X-ray is used instead of gamma-ray. It is almost impossible, however, to make an X-ray of a branch connection in the field. Gamma-ray equipment is more portable, and thus each of the radiograph methods has its own sphere of usefulness.

Not too long ago, a welder was just an "iron burner" in the lingo of the "Old Cat" pipeliner, but today he is a craftsman upon whose work rests responsibility far beyond any dream of his black-smithing ancestry.



Collection of straps showing results of tests. Examples include root bend, face bend, branch connection (throat), branch connection (point), tensile strength, and nick break tests.

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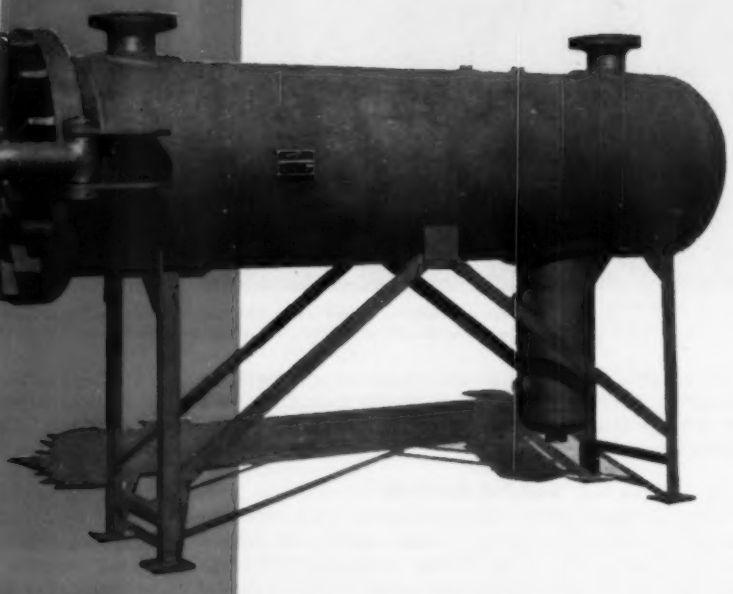

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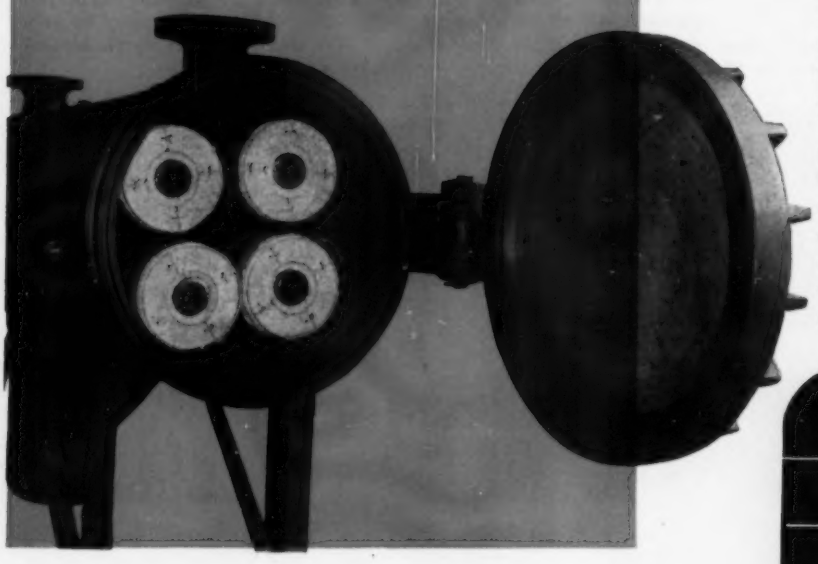

The HP-700 is rated from 750 to 1000 GPM on gasoline and fuel oil. The four repack cartridges provide a total filtering area of approximately 5,500 square inches. This Separator-Filter effectively removes solid particles down to forty microns in size. Equipped with quick opening closures and other easy service features, this compact unit is designed especially for the pipeline industry. Write for detailed information.

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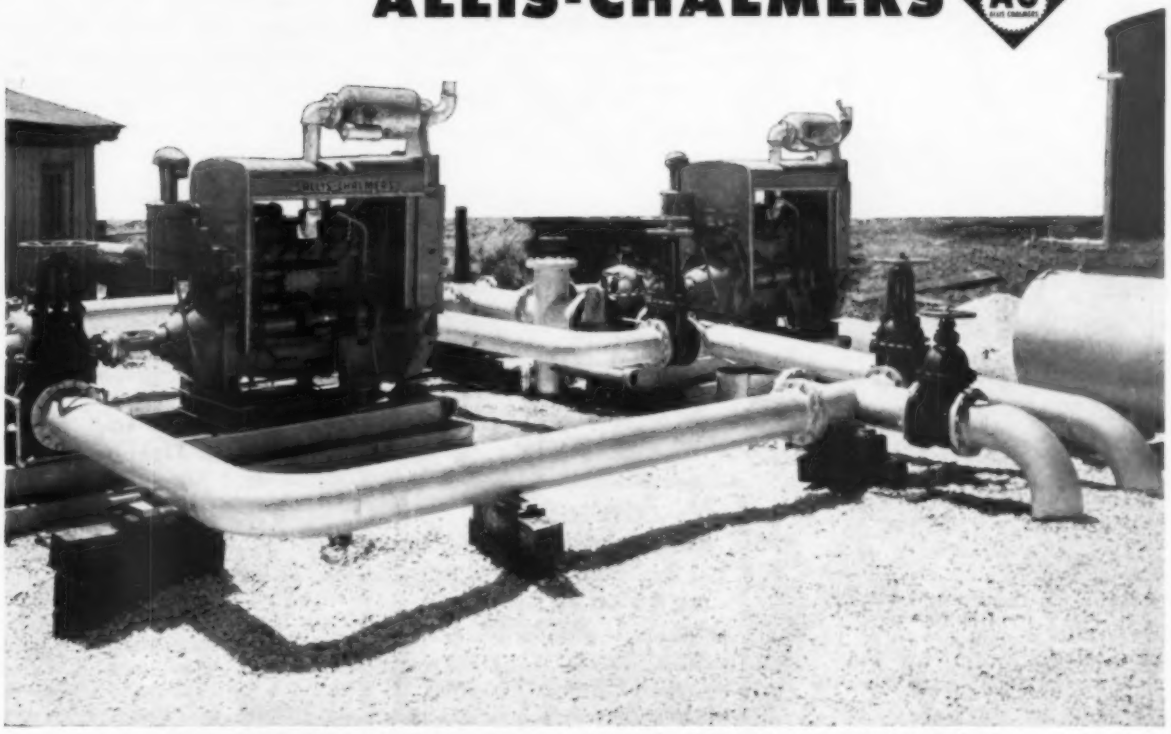


Two Allis-Chalmers 779 diesel engines pumping crude oil from storage tanks into tankers at the Westwago terminal for the American Liberty Marketing Co., New Orleans.

BC-17

Pipeline Projects

Trunkline Plans $81,500,000 Program

Trunkline Gas Company has filed with the Federal Power Commission in Washington its plans for an $81,500,000 construction and expansion program involving initially an increase of 135,000,000 cu ft of gas in daily capacity. Trunkline notified the commission that this is the first step in an overall program that eventually will supply 200,000,000 cu ft of gas daily to Consumers Power Company of Jackson, Michigan, a utility that serves a large area of outstate Michigan.

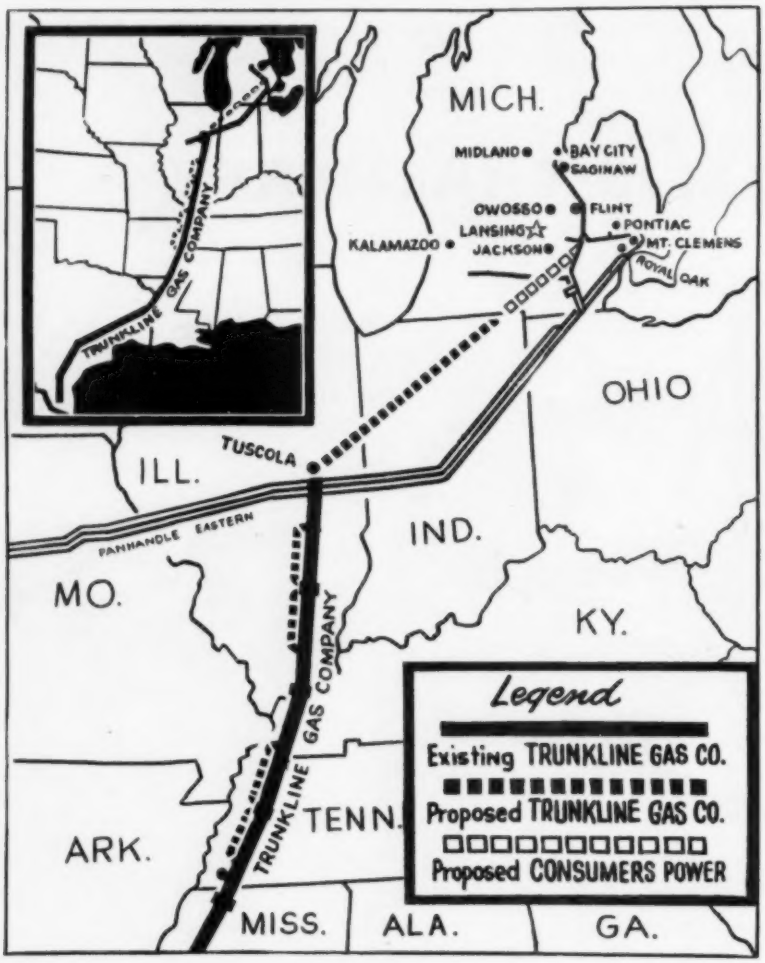
W. K. Sanders, president of Trunkline, announced that the company will build, as soon as Federal Power Commission approval is granted, a 204-mile extension of its main line from central Illinois to the Indiana-Michigan border where it will connect with the Consumers Power Company system. Consumers is one of Michigan's largest distributors of natural gas, serving 460,000 homes in some 300 communities in that state.

Mr. Sanders stated: "The Consumers Power Company has advised Trunkline Gas Company that due to the growing demand for natural gas as a domestic fuel, Consumers Power Company has experienced an acute shortage in the past few years. Many of those on the waiting list of over 160 thousand homes will be served by this new supply from Trunkline." The principal areas served by Consumers are grouped around the cities of Pontiac, Flint, Saginaw, Lansing, Alma, Bay City, and Marshall.

Mr. Sanders also said, "The Trunkline expansion is designed solely to supply Consumers Power Company, and there is no plan to attach other customers. The additional facilities now proposed will increase Trunkline's delivery capacity from its present 375 million cubic feet of gas daily to 510 million cubic feet of gas daily in the first year of the deliveries to Consumers."

The announcement by Trunkline in Houston was timed to coincide with the company's filing the necessary documents for such an expansion with the Federal Power Commission in Washington. The Commission has been urged to give prompt consideration to this expansion program in order that Trunkline could begin its necessary construction by January 1, 1959, at the latest. The construction program will take about nine months to complete and is timed to provide gas to Michigan homes for the 1959-1960 winter heating season.

Trunkline, whose main office is at 5650 Kirby Drive in Houston, presently operates a 1200-mile pipeline from McAllen, Texas, to Tuscola, Illinois. The new construction program will include additional horsepower at one of its Louisiana compressor stations and a substantial amount of looping of its main line, as well as the extension to Michigan.



El Paso Natural Plans Pipeline From Austin Field

El Paso Natural Gas Company has filed with the Federal Power Commission for authority to build and operate a pipeline system to transport gas from the Aneth field, Utah, in the Four Corners area.

Projected are 13 miles of 20-in., 62 miles of 16-in., and 102 miles of various diameter field lines, plus compressor stations and dehydration plants. Approximately 100,000,000 cu ft of gas a day would be taken from the field by the pipeline.

Estimated cost of the project is $26,085,000.

Gulf Interstate to Lay 405 Miles of Pipeline

The Federal Power Commission has authorized the construction and operation of natural gas pipeline facilities, estimated to cost about $51,000,000, by Gulf Interstate Gas Company.

Involved in the authorization are about 351.7 miles of 30-in. main line loops between Louisiana and Kentucky and 54 miles of 24-in. lateral line loops in Louisiana. The commission granted temporary authorization for the construction of the facilities in January.

Texas Gas Asks to Spend $20,000,000 on Construction

Texas Gas Transmission Corporation has filed with the Federal Power Commission an application requesting authorization to increase the delivery capacity of the company's natural gas pipeline system by approximately 113,000,000 cu ft daily.

An expansion program that is outlined in the application will increase the daily deliverability from the nine-state Texas Gas system to about 1½ billion cu ft, according to W. M. Elmer, president of the company.

Addition of the facilities proposed in the application is expected to cost approximately $20,000,000! These facilities include 126 miles of new pipeline and 9040 additional compressor horsepower at existing compressor stations along the company's pipeline system that extends from Louisiana and Texas to Ohio.

According to Mr. Elmer's announcement, the gas reserves required for the increased deliveries that will be made possible by the system expansion are committed to Texas Gas. These sales to the company by suppliers have been authorized by the Federal Power Commission and the sources of supply are already connected to the Texas Gas system.

Pipeline and horsepower additions for which authorization is asked in the application include 92 miles of 30-in. pipeline, 19 miles of 26-in. line, and 15 miles of smaller diameter lines. The new pipelines will loop portions of the company's existing system in Louisiana, Arkansas, Mississippi, Kentucky, Indiana, and Illinois.

The additional compressor horsepower is proposed for six existing stations. They are at Pineville, Louisiana, Kenton, Tennessee, Calvert City, Kentucky, Slaughters, Kentucky, Dillsboro, Indiana, and Petersburg, Indiana.

Application for Offshore Line Filed by Tennessee

An application by Tennessee Gas Transmission Company for the construction and operation of pipeline facilities to attach natural gas reserves from offshore Louisiana fields, has been accepted for filing, the Federal Power Commission announces.

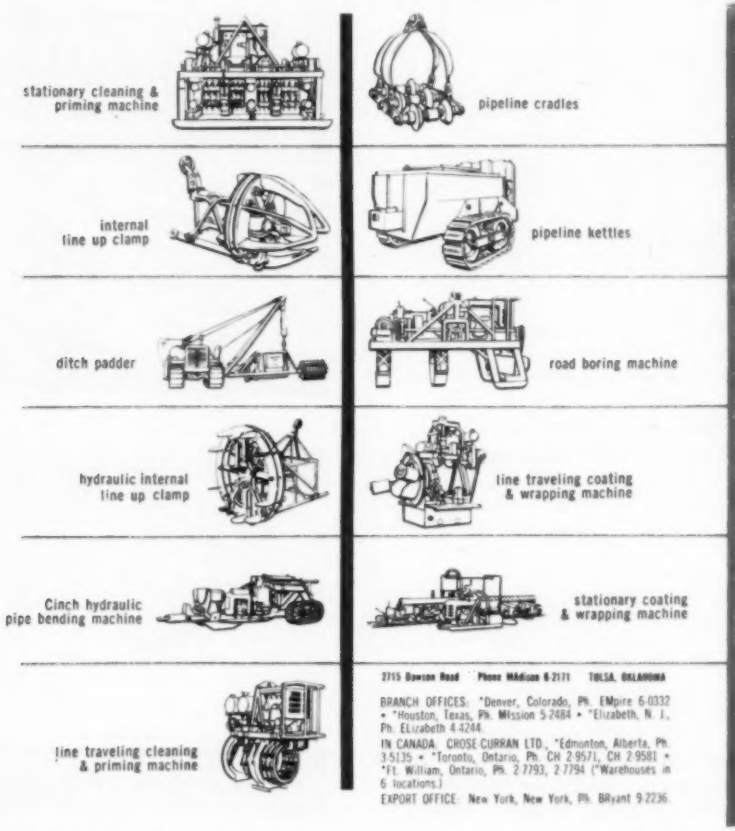
Tennessee Gas proposes to construct approximately 21 miles of 16-in. and 2 miles of 12¾-in. pipeline, at an estimated cost of about $2,868,700, to take delivery of natural gas underlying offshore Blocks 64 and 46. The company's application said the amount of reserves available from Blocks 64, 46, and 66 is estimated at about 403 billion cu ft. The FPC, on April 22, 1957, granted Tennessee temporary authorization to install facilities from Block 66.

Application Made for Southern California Line

Application has been made to the California Public Utilities Commission by Pacific Lighting Gas Supply Company for authority to construct facilities to deliver additional natural gas to Southern California.

The company, a subsidiary of Pacific Lighting Corporation, and the gas transmission and storage affiliate of the Southern California Gas Company and Southern Counties Gas Company of California, is seeking authority from the Commission to build and operate a 128-mile natural gas pipeline from the California-Arizona border to bring more natural gas to Los Angeles and the rest of the Southern California area. The gas would be delivered into the local distributing gas companies' transmission system at a point near Barstow, California.

This project, which will cost $21,000,000 for the pipeline and compressor facility, would tie in with the 1300-mile line being planned from Texas to the California border by Transwestern Pipe Line Company. Gas Supply Company earlier this year signed an agreement to purchase 350,000,000 cu ft of gas a day from Transwestern, when the multi-million dollar pipeline network is completed.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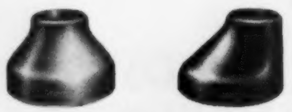
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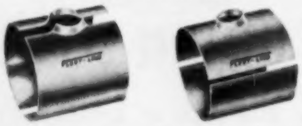
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Projects

Service Pipe Line in Major Expansion Move

Major expansion of Service Pipe Line Company's crude oil system in Wyoming, Colorado, and Kansas has been announced by H. G. Mariner, general manager. The several projects include construction of three new pump stations, addition of power at seven others, and the building of more than 100 miles of big-inch pipeline.

Approximately 11,500 hp will be added to the 870-mile system between Elk Basin, Wyoming, and Freeman, near Kansas City, Missouri. Included will be new pump stations at Herndon and Scranton, Kansas, and at La Grange, Wyoming.

Increased demand for Rocky Mountain crude, particularly black crude from Wyoming, influenced Service's decision to expand its east-west trunk line, Mariner said. The line carries oil to refineries near Kansas City, St. Louis, and Chicago, and through connecting pipelines to eastern destinations. Winter capacity will be increased up to 39,000 bbl per day.

Herndon station will employ two 2000-hp dual-fuel diesel engines with centrifugal pumps. At Scranton, Service will build an unattended, outdoor station of advanced design, using centrifugal pump with a 2000-hp electric motor. A third dual-fuel centrifugal pumping unit of 2000 hp will be added to the present two units at Laton station, in Rocks County, Kansas. An increase in power is also planned for the company's station at Sterling, Colorado.

A 2000-hp electric-centrifugal unattended pump station will be built at La Grange, Wyoming, on the Ft. Laramie, Wyoming-Sterling section of 20-in. line in Goshen County.

Further expansion in Wyoming includes the installation of larger motors at the Elk Basin, Kirby, Owl Creek, and Lost Cabin pump stations, northwest of Casper. A total of 2200 hp will be added at these four locations.

Mich-Wis Gets Full Commission Approval

The Federal Power Commission has adopted a decision by one of its presiding examiners authorizing Michigan Wisconsin Pipe Line Company to construct natural gas facilities, at an estimated cost of about $19,453,000, which will expand its system capacity by 40,000,000 cu ft daily. The decision was filed by Presiding Examiner Howell Purdue on June 4.

The facilities consist of about 56 miles of 20-in. lateral line from Michigan Wisconsin's main line to the Laverne field, Harper County, Oklahoma; field lines, metering and appurtenant facilities in the Laverne field; nine new main line compressor stations aggregating 31,500 hp; additional horsepower in four existing compressor stations, and a 20.5-mile loop of its 22-in. line to the Austin storage field in Michigan.

NGPCA's Big Program Temporarily Approved

The Federal Power Commission has granted Natural Gas Pipeline Company of America temporary authorization to construct approximately 490 miles of 36-in. and 21 miles of 26-in. loop lines between Fritch, Texas, and Joliet, Illinois, and additional metering facilities near Joliet, at an estimated cost of about $81,840,000.

The temporary authorization does not permit operation of the facilities and was conditioned in that the facilities shall not be used to transport volumes of natural gas for resale on a firm basis to U. S. Steel Corporation and Inland Steel Company in the Chicago, Illinois — Gary, Indiana, area, pending final FPC decision on such sales. The commission advised Natural that any increase in sales obligation above 100,000,000 cu ft per day would be subject to further showing of Natural's ability to perform.

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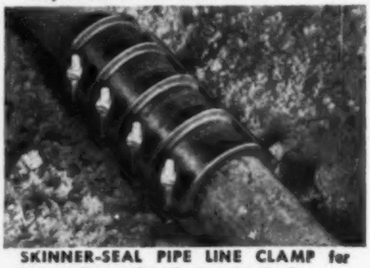
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PIPELINE PERSONALS

▸ **George W. Horsley,** senior vice president and director of The East Ohio Gas Company, has retired. Horsley has been a company director for 25 years.

▸ **Charles M. Kittrell,** formerly administrative assistant to the manager of Phillips Petroleum Company's supply and transportation department, was transferred to New York City as manager of the newly established New York office of the department. **C. M. McCormick** was named assistant to the manager of the supply division, and **L. A. Whitehair,** formerly administrative assistant to the manager of the pipeline division, was appointed industrial relations director of the department, replacing McCormick.

▸ **Harvey Cecil Evans** has been named division oil movement superintendent and **Frank Osro Perry,** division maintenance and construction superintendent for Humble Pipe Line Company at Houston. **Russell Leroy Baird Sr.** was named superintendent of the Tomball district replacing Evans and **Edward Isador Walker,** superintendent of Webster district. Perry was district superintendent at Pierce Junction before his promotion. Baird was district chief clerk at Tomball and Walker was assistant superintendent at Junction.

▸ **Mills Cox,** who has been executive vice president of Transwestern Pipeline Company, Houston, Texas, for the past several months, has been named president and chief executive officer.

▸ Three supervisory changes in the pipeline section of Panhandle Eastern Pipe Line Company have been announced. **Stanley T. Smith,** assistant superintendent at Paola, Kansas, moved to Olpe, Kansas, as district superintendent, replacing **W. E. (Bill) Rigsby,** who retires. **W. L. (Woody) Wood** replaces Smith at Paola and **J. B. Walters,** regional clerk for Region 2 at Paola, has taken Wood's place as the assistant superintendent at Houstonia, Missouri.

▸ **Robert L. Wagner** has been promoted to construction vice president, Somerville Construction Company. In his new capacity he will coordinate the construction activities of the main company at Ada, Michigan, and the subsidiary companies at Peoria, Illinois, and Toronto, Ontario.

▸ **Robert B. Smith,** formerly coordinator of research for the Columbia Gas System Service Corporation, has been named assistant director of research for the American Gas Association. In his new capacity, Smith will work with **T. L. Robey,** AGA director of research.

▸ **P. A. Gass** has been promoted a senior vice president of Northern Natural Gas Company. He was formerly vice president in charge of personnel. In his new position he will continue to represent the personnel department and Peoples Natural Gas division on the company's management board. In addition, he will serve as a member of the executive and policy committee for the company's management board.

▸ **John A. Schuchart** has been elected an assistant secretary of Northern Natural Gas Company. He was supervisor of the document section of the secretary department prior to his promotion.

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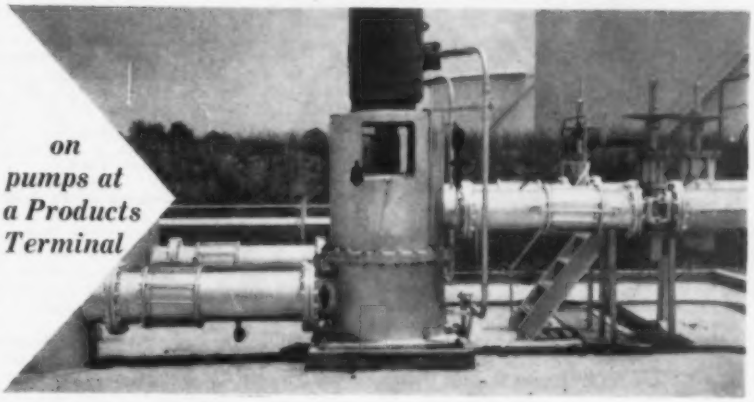

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WITH THE PIPELINE CONTRACTORS

● **Brown & Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has contract with *Texas Eastern Transmission Corporation* to furnish field supervision for construction of 626 miles of 30-in. loops along the company's line between Beaumont, Texas, and Uniontown, Pennsylvania.

● **Construction Service Company, P. O. Box 311, Bound Brook, New Jersey.** Has 18 miles of 12-in between Trinity and Gala, Virginia, for *Roanoke Gas Company*.

● **F. E. Shaw, Ltd., 530 S. Vidal Street, Sarnia, Ontario.** Has 40 miles of 6 to 10-in. line for *Dominion Natural Gas Company, Ltd.*, in the Brantford, St. Catharines, and St. Thomas districts. Has 67 miles of 6 to 20-in. transmission lines for *Union Gas Company*, Chatam, Ontario, to Dawn, London, St. Marys, Stratford, Kitchener and Guelph.

● **Macco Corporation, 14409 Paramount Blvd., Paramount, California.** Has 20 crews installing and replacing gas pipelines in Southern California area for *Southern California Gas Company* and *Southern Counties Gas Company*.

● **Collins Construction Company, P. O. Box 86, Port Lavaca, Texas.** Has contract on 7240 ft 30-in. Mississippi River crossing at Happy Jack, Louisiana, for *Tennessee Gas Transmission Company*.

● **Sheehan Pipe Line Construction Company, 514 National Bank of Tulsa Building, Tulsa, Oklahoma.** Has contract for 51 miles of 10-in. and 6 miles of 6-in. for *Buckeye Pipe Line Company*. The 10-in. line is between Utica and Syracuse, New York; the 6-in. is near Auburn, New York.

● **Panama-Williams Corporation, 1418 Melrose Building, Houston 2, Texas.** Has 100 miles of 24-in. from Hughesville, Pennsylvania, to the Delaware River for *Transcontinental Gas Pipe Line Corporation*. Also 30 miles of 30-in. for the same company in the Delaware River area.

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has 212.5 miles 20-in. crude line for *Socony Mobil Oil Company de Venezuela*. Line will extend from San Silvestre field to Puerto Cabello on the Caribbean Coast. Has contract for 42 miles, 24-in. in Louisiana for *Southern Natural Gas Company*.

● **Dutton-Williams Brothers, Ltd., North Canadian Oil Building, Calgary, Alberta.** Has 57 miles of 30-in. line for *Trans-Canada Pipe Lines*. Has contract for 80 miles of gathering lines for *Westcoast Transmission Company's* natural gas grid system in the Peace River region; plans call for laying some 20-in. as an extension to the main line and also smaller diameter lines down to 6-in. for the Blueberry field.

● **Harvey B. White Limited, Box 158, Windsor, Ontario.** Has undetermined amount of 4 to 8-in. distribution lines for *Consumers Gas Company* in cities of Pickering and Whitby, Ontario. Has undetermined amount of 2 to 6-in. distribution lines throughout Windsor, Ontario, for *Union Gas Company*.

● **O. R. Burden Construction Corporation, Box 5216, Tulsa, Oklahoma.** Has 32.8 miles of 16-in. from Muncie, Indiana, to east of Hollansburg, Ohio, for *Panhandle Eastern Pipe Line Company*. Has 76 miles of 20-in. from Ft. Laramie, Wyoming, to Clendo Junction and from Casper to Welch for *Service Pipe Line Company*. Also has 54 miles of 12-in. to take up and recondition in Goshen, Platte, and Converse counties, Wyoming, for same company. Also has 29.5 miles of 8-in. to raise, recondition and replace between *Service's* Post and Cogdell stations in Garza and Kent counties, Texas. Has 47.7 miles of 12-in. from that company's Salt Creek station in Natrona County, Wyoming, to North Fork station in Johnson County and from Salt Creek to Casper stations. Has contract for gathering system consisting of approx. 84 miles of 4 to 16-in. pipe in Jack and Wise counties, Texas, for *Natural Gas Pipeline Company of America*.

● **Piggott Construction, Ltd, Calgary, Canada.** For *Interprovincial Pipe Line Company*, 82 miles of 24-in. loops in Alberta and Saskatchewan. For *Alberta Gas Trunk Line Company*, 145 miles of 24-in. from Pincher Creek field to Princess Junction, Alberta.

● **Hallmac Construction Company, 3701 Buffalo Drive, Houston, Texas.** Has undetermined amount of gathering system line for *El Paso Natural Gas Company* in the Four Corners area of New Mexico and Colorado. Has indeterminate amount of various size line for *Pacific Northwest Pipe Line Corporation* in the Four Corners area and in Big Piney near Kemmerer, Wyoming.

● **Houston Contracting Company, 2807 Buffalo Speedway, Houston 6, Texas.** Has 216 miles of 30-in. gas line loops for *Gulf Interstate Gas Company* in Louisiana, Mississippi, and Tennessee. Has 38 miles of 30-in. gas line for *Tennessee Gas Transmission Company* from the Gulf Coast to Yscloskey, southeast of New Orleans, Louisiana. Has Atchafalaya River crossing for *Transcontinental Gas Pipe Line Corporation* just north of Melville, Louisiana, consisting of one 30-in. and one 18-in. line.

● **Mannix Company, Ltd., 737 Eighth Avenue West, Calgary, Alberta.** Has 90 miles of 10-in. between North Bay and Sudbury, Ontario, for *Northern Ontario Natural Gas Company, Ltd.* Also has 220,000 ft of 2 to 8-in. distribution lines for same company in Sudbury. Has 20 miles of 2 to 14-in. for *British American Oil Company, Ltd.* consisting of a wet-gas condensate gathering system in the Pincher Creek, Alberta, area. Has 90 miles of 30-in. between Hearst and Kapuscasing, Ontario, for *Northern Ontario Pipe Line Crown Corporation*.

● **Vaughn & Taylor Construction Company, Inc., Box 3266, Odessa, Texas.** Has 22 miles of 2 to 20-in. waterflood system near Wickett, Texas, for *Gulf Oil Corporation*.

● **H. L. Gentry Construction Company, P. O. Drawer 32, Perrysburg, Ohio.** Has 40 miles of 24-in. between Oneida and Phoenix, New York, for *Niagara Mohawk Power Corporation*.

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● **Majestic Contractors Limited, 408 Royal Trust Building, Edmonton, Alberta.** Has contract for 70.9 miles, 30-in., *Northern Ontario Pipe Line Crown Corp.*, between Beardmore to Longlac, Ontario. Has undetermined amount of gathering system for *Producers Pipeline Ltd.* in the Estavan, Saskatchewan, area. Has contract to lay city distribution system in Cooksville, Ontario, for *Consumer Gas Company*. Has city distribution system in Guelph, Ontario, for *Union Gas of Canada*. Has contract with *Trans-Canada Pipe Lines Ltd.* for 80 miles of 30-in. from Iroquois Falls to Kirkland Lake, Ontario.

● **Arey Pipe and Construction Company, Inc., Box 1501, Pampa, Texas.** Has 105 miles of 6-in. for *West Emerald Pipeline Corporation* between Amarillo, Texas, and Tucumcari, New Mexico.

● **Western Pipe Line, Inc., 1011 San Jacinto, Austin 66, Texas.** Has 94 miles of 30-in. for *Northern Ontario Pipe Line Crown Corporation* between Hawk Lake and Hyndeman, Ontario.

● **Lone Star Pipe Line Constructors, Inc., 10301 Shady Trail, Dallas, Texas.** Has 143 miles of 20-in. crude line between Teague and Houston, Texas, for *Sinclair Pipe Line Company*.

● **Fulton Banister, Ltd., 625 Northern Hardware Building, Edmonton, Alberta.** Has 100 miles of 18-in. for *Alberta Gas Trunk Line Company, Ltd.*, from Burstall at the Alberta border to Provost, Alberta. Also has 22 miles of gas gathering line in the Provost field for *Provo Gas Producers, Ltd.*, consisting of constructing gathering system and wellhead tie-ins—3 to 12-in. pipe; this gas to be fed to *Alberta Gas Trunk Lines*. Has contract with *Saskatchewan Power Corporation* for 124 miles of 10-in. line from Steelman to Regina and 38 miles of 12-in. from main line's present terminus at Moose Jaw extending to Regina.

● **Banister Construction, Ltd., 625 Northern Hardware Bldg., Edmonton, Alberta.** Has undetermined amount of 2 to 6-in. extensions to existing systems in cities and towns in Saskatchewan, plus approximately 5000 consumer service connections, for *Saskatchewan Power Corporation*. Has contract for construction of transmission and distribution system in the town of Wilkie, Saskatchewan, for the *Saskatchewan Power Corporation*.

● **Oklahoma Pipe Line Constructors, P. O. Box 13227, Dallas 20, Texas.** Has 100 miles of 30-in. for *Creole Petroleum Corporation* between Temblador and Caripito, Venezuela; this is the company's first Venezuelan venture since 1944. Has 90 miles of 30-in. (known as Spread 14) for *Trans-Canada Pipe Lines, Ltd.*, from Toronto, Ontario, northward. Has 96 miles of 30-in. line from Columbus, Mississippi, to Tennessee River for *Tennessee Gas Transmission Company*. (This project to be performed by Oklahoma Contracting Company.)

● **Morrison-Shivers, Ltd., Box 1076, Austin, Texas.** Has 48 miles of 30-in. for *Northern Ontario Pipe Line Crown Corporation* between Nipigon and Beardmore. Also has 62 miles of 30-in. for *Trans-Canada Pipe Lines* at North Bay, Ontario.

● **Engelking and James, Ltd., Edmonton, Alberta.** Has 88 miles of 14-in., 3.5 miles of 16-in. and a total of 23 miles of various other lines for *Saskatchewan Power Corporation* from and in Success and Hatton gas fields in Saskatchewan.

ABC performing two jobs...

ABC MOBILEHOMES CAN BE BOTH A HOME AND OFFICE

Whatever your need, there's an ABC to give you comfortable service even after years of hard use. There's 3500 cu. ft. of living and working space in a large ABC Mobilehome. ABC's cantilevered steel chassis has standard tread for safe towing. 1½" of insulation *all around* and 2" overhead with radiant floor heat make ABC comfortable in any climate. Plumbing and electrical wiring are to national codes for your protection.

Dust tight windows and doors, *fire proof galvanized steel roof and bottom* and temperature controlled aluminum siding make ABC safe and sound anywhere.

36 Floor Plans — 8' and 10' Widths — 1 to 3 Bedrooms

See your ABC dealer listed in the telephone book or write to

ABC Coach Co. INC.
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TAPPING TEE
FOR GAS MAINS
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PART NO. 4911 - GS
Made from Schedule 40 ASTM A-106 A or B carbon steel

● *WELDS TO MAIN AND 1-1/4" SUPPLY LINE*
● *COLD-FORMED FROM SEAMLESS STEEL TUBE*
● *EXTRA STRONG, EXTRA SMOOTH INSIDE AND OUT*
● *COMPLETE WITH PLUG AND CAP*

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since 1937 manufacturers of wrot copper, carbon and alloy steel fittings

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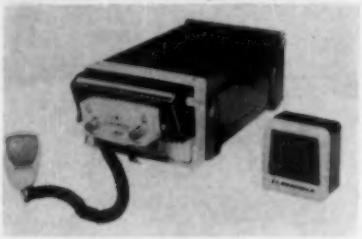
Its New Pipeline Equipment

"T-Power" Radiophone



Motorola has announced a new mobile 2-way radiophone operating in the 450-470 mc frequency band. The equipment utilizes transistors in the power supply rather than the traditional mechanical vibrators and so fills out the Motorola "T-Power" radio line. The new unit makes "T-Power" radio available in all frequency bands and all conventional ratings. *Motorola, Inc.*

Circle number (81) on reply card.

Telemetering Transceivers

TTR-series telemetering transcievers are designed for transmission and reception of digital information over telephone lines, radio, or microwave links. This unique pulse code system provides output (without conversion equipment) for data handling, computing, printing, or supervisory control systems. TTR master and TTR-A slave units are used for remote control and central data gathering in gas and oil lease production, and for the control and monitoring of pumping, compressing and switching operations in gas, oil, and product pipelines over any distance. *Southwestern Industrial Electronics Company.*

Circle number (82) on reply card.

Mercury Vapor Fixture

Appleton Electric Company has announced a new 24-in. high-bay lighting fixture for use with mercury vapor lamps. The fixtures meet the National Electrical

Code Standard for 1000-w mercury vapor lamps, are precision-designed with a vented hood for lower operating temperatures and minimum dirt accumulation, and are electro-chemically processed with a hard protective coating, which is easily cleaned to maintain the original high efficiency. *Appleton Electric Company.*

Circle number (83) on reply card.

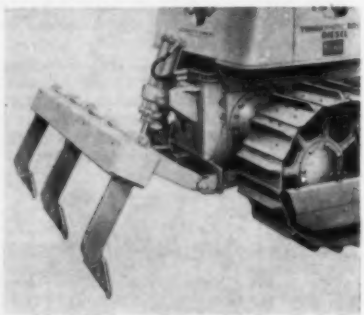
50-Watt Mobile Radio

A 50-w mobile radio unit with a completely transistorized power supply, the first such equipment to be encased in an "eight-inch" housing, is available. Incorporates a unique front panel 45-deg angle "heat sink" design to allow optimum performance whether the unit is installed horizontally, vertically, or on its side. With the transistor section designed as part of the heat sink section, heat absorption from the transistor section is at a maximum. *Allen B. Du Mont Laboratories, Inc.*

Circle number (84) on reply card.

Heavy Duty Ripper

A new heavy duty ripper, built to match the tremendous pulling power of torque converter-equipped Case Terra-Trac Model 800 and 1000 crawler tractors under extremely tough conditions, is



announced. Designed to provide maximum strength and penetration in hard-packed soils, the new ripper digs to a depth of 20 in. *J. I. Case Company.*

Circle number (85) on reply card.

Digital Read-Out Tank Gage

An automatic tank gage by Shand and Jurs, unit 2006, features digital read-out with large, easy-to-read, white on black numerals; aircraft quality aluminum castings in modern, clean design; quality components; accurate, uniform tolerances on all machined parts; efficient, rugged construction — maintenance-free; faster, easier procedure; ready acceptance of transmitter for remote reading systems — no disturbance to pipe or gage reading; universal mountings for installation on any tank. *Shand & Jurs Company.*

Circle number (86) on reply card.

3-in. Quintuplex Pump

Frank Wheatley Pump and Valve has added to its line of plunger pumps the 5P-300. The new 3-in. quintuplex pump operates at 80-hp, developing 500 rpm, and producing 4300 bbl per day at 3000 psi. This performance was achieved by manifolding two additional cylinders to the P-300 triplex pump, and is said to make the 5P-300 equal in performance to a 4-in. triplex pump with savings in weight and expense. *Frank Wheatley Pump & Valve.*

Circle number (87) on reply card.

35-Ton Crane Lifts

Safe load lifts up to 35 tons with a 40-ft boom are made by the new Koehring 435 truck crane. Capable of swinging a

120-ft boom, the 435 can use boom jibs 15, 20, 25, or 30 ft long when extra reach is necessary. Safety boom limit stops and automatic power boom lowering are standard equipment. *Koehring Division.*

Circle number (88) on reply card.

Rock Backhoe Bucket

Schield Bantam Company has available a new heavy-duty rock bucket for its goose-neck backhoe attachment. The new 25-in. bucket features heavy-duty construction throughout, and is adaptable to Bantam's goose-neck backhoe design on either the carrier-mounted, crawler-mounted, or self-propelled cranes-excavators. *Schield Bantam Company.*

Circle number (89) on reply card.

Ultrasonic Degassing of Liquids

New ultrasonic continuous degassing equipment for application in liquid flow fields is announced. Stainless steel ultrasonic equipment degasses liquids continuously when connected into a pipeline at rates up to 5 gal per min. Coating liquids, slurries, emulsions, water, oils, some plastics and many other liquids are handled. *General Ultrasonics Company.*

Circle number (90) on reply card.

Maloney's "Texas Steer"

Pushing the "drag section" through the casing on highway crossings has long been a time consuming, expensive job.

The "Texas Steer" eliminates the delay and expense commonly encountered — hanging up insulators or breaking insulators during the drag. *F. H. Maloney Co.*

Circle number (91) on reply card.

Tank Level Detector-Controller

Major technological advances have resulted in lowering the cost of the AccuRay Tank Level Detector-Controller to make it competitive price-wise with conventional float-level controllers. A major feature of the equipment is that no part of the instrument extends into the tank or vessel. It is installed completely external to the tank. Thus it is completely free from fouling by process material and is readily accessible for maintenance. In addition, the instrument can be fail safe for either the high level or low level signal. The AccuRay Tank Level Detector-Controller can be used in either of two modes of operation: (1) It can be installed so as to provide a relay closure signal when the level rises above or falls below the level of the detector; or (2) It can be installed so that both a high level and a low level signal can be provided from one instrument. Accuracies are available to ± 1/16 in. *Industrial Nucleonics Corporation.*

Circle number (92) on reply card.

24-Channel Microwave

A compact transmitter-receiver unit for microwave radio relay systems that provides five times the previous one-package channel availability, and can be inexpensively pole-mounted, is announced. The MM-9E operates with a minimum of interference from atmospheric conditions, permitting uninterrupted remote control of a pipeline system from a central point, with no threat of broken wire circuits in ice or snow storms.

The MM-9E provides 24 channels for voice communications, facsimile transmissions, teletypewriter, and remote control functions. *Radio Corporation of America.*

Circle number (93) on reply card.

Radio Conversion Kits

New conversion kits now available from General Electric Company help two-way radio users to make the transition from wide-to-narrow band, which will take place gradually in the next 5 years. However, the company cautioned that the FCC still has Docket 12295 pending on the subject of implementing the rules and licensees may want to wait until rules are finalized before making conversions. The new kits take into consideration possible requirements that may result from FCC action at a later date. *General Electric Company.*

Circle number (94) on reply card.

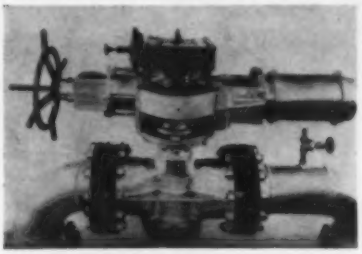
"Little Boomer" Sideboom

Improved design of the hydraulically operated "Little Boomer" sideboom, which is attached to the new John Deere 440-IC crawler tractor, is announced. It employs one double drum winch in place of the 2 separate winch drums that were formerly used. This change puts the winch drum in a position where the operator can easily check the condition of the cables at all times. This design also permits a streamlined arrangement of the hydraulic motors and hoses, which provides more accessibility for inspection and maintenance. The equipment is capable of handling 2 to 10-in. pipe. *Midwestern Manufacturing Company.*

Circle number (95) on reply card.

Valve Regulator Controls

Rockwell-Nordstrom Valve Regulators are now available with Republic positioners and controllers — produced by Rockwell Manufacturing Company's recently acquired subsidiary, Republic Flow Meters Company.

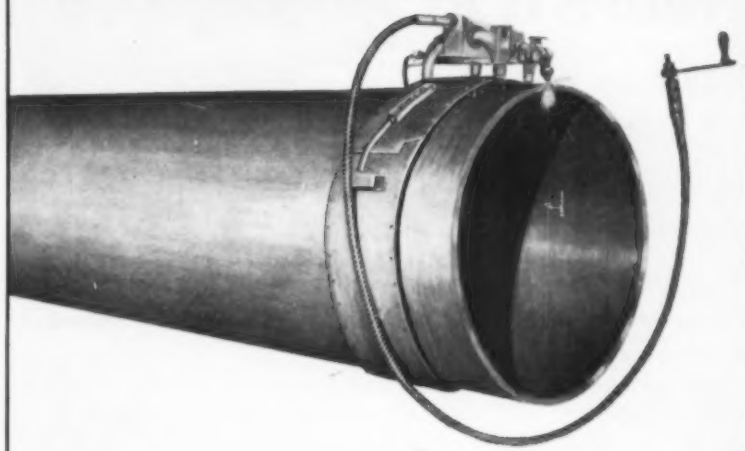


The Rockwell-Nordstrom valve regulator, introduced last year, is a pneumatically controlled, cylinder operated lubricated plug valve regulator designed to provide high-pressure large-volume gas regulation with minimum pressure loss. Republic Controls consist of an accurate (vector type) pressure controller and a feed-back type valve positioner. An increase or decrease of downstream pressure causes a change in the output of the pressure controller, which, in turn, causes the valve positioner to apply pneumatic power to the cylinder operator, thus repositioning the valve and controlling the downstream pressure at the set point. *Rockwell Manufacturing Company.*

Circle number (96) on reply card.

BEVELS 6" PIPE

BEVELS 48" PIPE



C-R-C IMCO BEVELERS fit all pipe sizes 6" to 48" O. D., cut perfect bevels, and out-of-round pipe, too. Single lightweight unit does work of several, costs you less to buy and use.

ONE BEVELING KIT FOR ALL YOUR JOBS!

For additional information see page 108, Pipeline Composite Catalog.

The CRC IMCO Pipe Beveling Kit contains a complete range of bands for beveling a variety of pipe sizes. With this convenient selection of sizes, the operator need only make one trip to handle all pipe beveling requirements including back beveling. The sturdy steel case and number of bands are optional.

CRC

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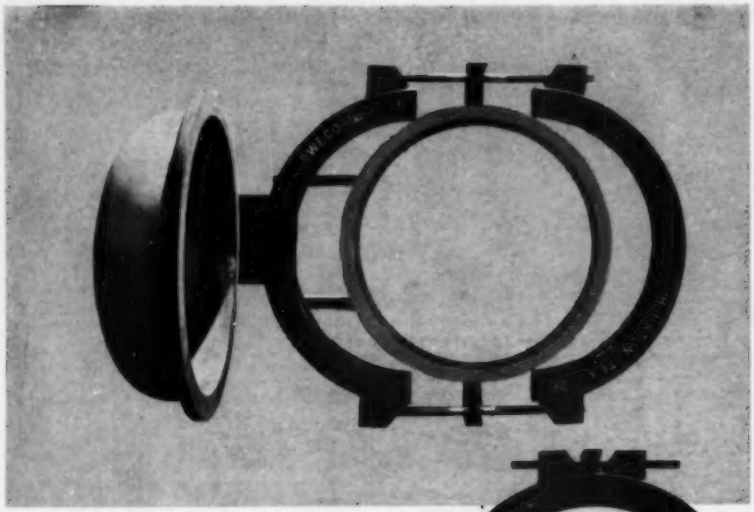


New SWECO Closure!

EASY TO INSTALL,

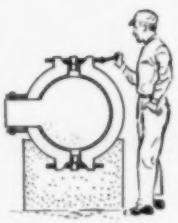
TO OPEN AND CLOSE •

ECONOMICAL TO

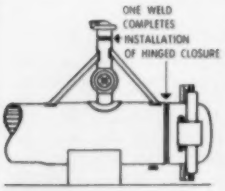
MAINTAIN • SAFE

For scraper traps, blowdowns, meter runs, vessels, tanks, strainers, filters, heat exchangers, where blind flanges or manways are required.

EASY TO INSTALL. The Sweco Hinged Closure comes completely assembled. No davits, hoists or stud bolts necessary. Installed with only one weld.



EASY TO OPEN AND CLOSE. One man with any standard wrench can easily open and close a 32" 1000# W.O.G. Sweco Hinged Closure in a few minutes. No threads or lugs to engage or flanges to line up when opening or closing. *Hinge is integral part of every Sweco Closure.*



SAFE. Thoroughly tested. Door of the Sweco Closure cannot be opened without absolute pressure relief. Yoke acts as safety cage until completely spread.

ECONOMICAL TO MAINTAIN. Oil resistant seal of the Sweco Closure is a static "O" ring which does not move and is not rubbed . . . assuring long seal life.

STOCK ITEMS in all pipe sizes 2" through 32", 1000# W.O.G. Larger sizes and bores available.

Call or write today for complete information. Let us show you how we are helping pipeline companies save time, money, and manpower with the all new Sweco Closure.

SWECO

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New Equipment

Jet Pump Motor

A totally enclosed starting switch that provides complete protection from dust and foreign materials is one of the many features in A. O. Smith Corporation's line of horizontal and vertical jet pump motors. Available in single and polyphase models ranging from ½ to 2 hp, the jet pump motors are engineered to insure torque, speed, and operating characteristics perfectly matched to the needs of the pumps they power. *A. O. Smith Corporation.*

Circle number (97) on reply card.

Magnetic Computer Tape

A "sandwich construction" magnetic tape for computer and instrumentation use is said to eliminate oxide rub-off, extends equipment life, and outwear conventional instrumentation tapes by 10 times or more. Secret is a thin, low-friction, plastic layer over the magnetic coating, which prevents the oxide from contacting the recording head at any time, thereby eliminating all wear on the oxide itself. *Minnesota Mining and Manufacturing Company.*

Circle number (98) on reply card.

New Literature

Metallic Sealing Rings

A comprehensive 8-page brochure describes and illustrates the performance and use of metallic sealing rings. The brochure points out that these rings will withstand high temperatures and high pressures and assure a minimum amount of leakage. *Metal Products Division, Koppers Company, Inc.*

Circle number (99) on reply card.

A-C Tractor Shovel

Catalog covering the design, engineering, construction, and operating features of the Allis-Chalmers HD-6G tractor shovel is available. Includes HD-6G's specifications, list of interchangeable attachments that are available to increase versatility, and many illustrations. *Construction Machinery Division, Allis-Chalmers Manufacuring Company.*

Circle number (100) on reply card.

Microwave Tower Lighting

A new catalog describes 300 MM beacons, obstruction lights, photo-electric controls, beacon flashers, mircrowave tower control and alarm units, remote lamp failure indicator systems, and complete tower lighting kits for AM, FM, TV, and unattended microwave towers. *Hughey & Phillips, Inc.*

Circle number (101) on reply card.

Data Processing

A 4-page bulletin describes the Model 123 Data Processing System, featuring pinboard programming and all solid state construction. The system can be used wherever variables such as temperatures, pressures, flows, etc., are to be recorded. *Beckman Systems Division.*

Circle number (102) on reply card.

Data in Graphic Form

Today, as industry continues to adopt systems of automation to handle large amounts of data, automatic methods must be devised to prepare this data into graphical form. The method used is described in a recently published manual, "Graphical Presentation with the Univac 120 Punched-Card Electronic Computer." *Remington Rand, division of Sperry Rand Corporation.*

Circle number (103) on reply card.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Simplified Computer Method

Bulletin describes the unusual features of a new programming method for computers. This system (known as Intercom 1000) has been designed for use with the Bendix G-15 general purpose digital computer and is a major simplification in the process of writing instructions to a computer. The system can be learned in four hours or less, with no previous computer experience. *Bendix Computer Division.*

Circle number (104) on reply card.

Compressors, Gas Turbines

The new composite catalog, issued by Clark Bros. Company, one of the Dresser Industries, follows the principle that no two plant operations are exactly alike and that selection of proper compressors and gas turbines is determined by application requirements and careful unit engineering. The catalog features the complete line of standard Clark products, highlighting the latest engineering and performance data with reference to the petroleum, refining, gas, pipeline, chemical, petrochemical and other industrial applications. *Clark Bros. Company.*

Circle number (105) on reply card.

Speed Reducers

A new booklet, "Shaft-Mounted Speed Reducers," is available from Westinghouse. The 10-page engineering manual discusses selection, horsepower ratings, dimensions, construction, installations and maintenance for the new Moduline shaft-mounted speed-reducing units. *Westinghouse Electric Corporation.*

Circle number (106) on reply card.

Methanite Used for Liquid Gas Storage

Floriden Company has issued a bulletin giving technical data and specifications on products made from fullers earth and activated bauxite. Although the products are many, three are of especial interest to pipeline people. One is Methanite, used in storage of natural and petroleum gases, adsorbing up to 90 percent as much hydrocarbon gas as would be occupied by the liquefied gas itself. Storage of gases on Methanite in the adsorbed state is said to afford a high degree of safety as compared with liquid storage. Other products, are Florite desiccant for dehydration of gas, and Florex for water treating. *Floriden Company.*

Circle number (107) on reply card.

Custody Transfer

Custody transfer and inventory control are vital operations in the pipeline industry, and both depend upon accurate representative sampling of materials being transferred. Precise, automatic methods of sampling directly from pipelines are described in an 8-page bulletin. *Proportioneers, Inc.*

Circle number (108) on reply card.

Flange-Matching Tables

The familiar oil field supply store problem of "what forged steel flange mates with what plug valve?" is solved at a glance by Bulletin TT 880, "Flange Matching Tables," published by Tube Turns Division of Chemetron Corporation (formerly National Cylinder Gas Company). Forged steel flanges, rated according to intended service pressure at elevated temperatures, and lubricated plug valves, usually given WOG ratings, are properly matched in the new bulletin, eliminating the need for a user to refer to several catalogs to make the proper selection. Pertinent bolting and gasket data is also provided. *Tube Turns Division.*

Circle number (109) on reply card.

Valve Laboratories

Research and experimental laboratories devoted exclusively to steel valves are described in a new four-color 32-page booklet by Edward Valves. Using the techniques of a photo tour, the booklet shows how valve research is carried on through flow studies, stress analysis, accelerated temperature tests, radiographic and other inspections, nuclear flow loop tests, aging procedures, packing studies, foundry investigations, and basic metallography. *Edward Valves, Inc.*

Circle number (110) on reply card.

Diesel Engine Advancements

Two-color, 18-page bulletin describes and shows examples of significant advancements in diesel engine performance for V-type 4-cycle engines that are supercharged, supercharged and intercooled and Supairthermal. *Nordberg Manufacturing Company.*

Circle number (111) on reply card.

National Line Pipe

National Tube line pipe is given thorough coverage in a new bulletin. Drawings show in an interesting way how seamless and electric weld pipe are made. Valuable engineering tables also are included, as well as other worthwhile data. *National Tube Division, U. S. Steel Corporation.*

Circle number (112) on reply card.

DETERMINATION TO BUILD BETTER PIPELINES... A Mark of the Houston Contracting Man

Determination, backed by skill and experience, to build pipelines right has always been a quality of Houston contracting men. Many have been pipelining for twenty or thirty years. Houston Contracting superintendents have been with the Company from 16 to 21 years. You can rely on these men for better-built pipelines.

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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Canadian News Notes

Permit Asked for Saskatchewan Line

Gibson Petroleum Company, Ltd. has applied to the Saskatchewan Oil and Gas Conservation Board for permission to lay a 14-mile 4-in. crude oil gathering line to connect the Viewfield oil producing area in southeastern Saskatchewan with the main system of Westspur Pipe Line Company at its Midale terminal. There are six wells in the Benson field at Viewfield and two single wells outside the field area.

Trans-Canada Compressor Stations Under Construction

Five compressor stations are under construction on the main line of Trans-Canada Pipe Lines, Ltd., mostly in the western division. The three largest stations are in Saskatchewan. All rated at 10,200 hp, they are to be powered with three 3400-hp Clark engines each.

Station No. 2, at Burstall, is near the start of the line in eastern Alberta. The contractor is Dutton-Williams Brothers, Ltd., Calgary. Station No. 13, at Caron, a few miles west of Moose Jaw, identical to No. 2, is being built by Marwell Construction Company, Ltd., Vancouver. Station No. 25, at Moosomin, in eastern Saskatchewan, is under contract to Brown & Root, Ltd., and Fraser Brace Engineering Company, Ltd.

A smaller station is under construction at Ile des Chenes, 12 miles southeast of Winnipeg, at the point where the 34-in. main line in the western section ties into the 30-in. line that runs eastward across the rock and clay belt. Designated station No. 41, it will be powered by three 2500-hp Cooper-Bessemer engines for a total of 7500 hp. The contract was let to Poole-Pritchard, Ltd.

At North Bay, Ontario, is the smallest station, No. 116, rate at 5400 hp. It is to be powered by three 1800-hp Cooper-Bessemer engines, and the contractor is The Fluor Corporation of Canada, Ltd. North Bay is the take-off point from the main line for the lateral line to Sudbury.

At the North Bay station an unusual problem of muskeg removal and backfilling had been completed by the end of June. A total of 5½ acres of muskeg soil had to be graded, involving the removal of 18,000 yards of muskeg down to a dense sand layer underlying it. Then 25,000 yards of sand were backhauled for filler material to provide a stable base for building foundations. A total of 98 cedar piles were driven to bedrock at depths of 25 to 35 ft, including 72 piles under the main compressor building.

In the compressor area a special rock base was laid for a depth of 6 in. over the compacted sand layer, to provide extra load-bearing support, and the compressor bed was poured 2 ft thick on reinforced concrete. The pillow blocks for the compressor engines were poured similarly, with a vibration pad under them, and bolted to the slab.

The engines were moved in on low-boy trucks, trestles were built up beside the pillow blocks, and the engines were skidded over the trestles onto the blocks. Each engine weighs about 60 tons.

A constructional feature that is understood to be new in Canada, at the North Bay station, is the use of sandwich wall panels consisting of a layer of 1½ in. of polystyrene foam between two outside layers of ⅛-in. flat asbestos board. The principal features are high insulating qualities with little weight, and the fact that the exterior surface needs no painting or other finishing. It is expected that the surface will weather to about the appearance of aluminum or stainless steel. The weight of the panels is only 2.12 lb per sq ft.

Great Northern Taking More Canadian Oil

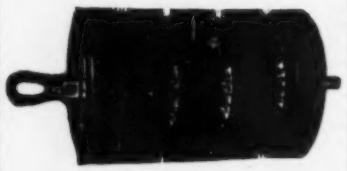
The July purchasing schedule of Great Northern Oil Purchasing Company, Regina, for Saskatchewan and Manitoba crude oil, revealed an increase of 2133 bbl per day over May, to 49,800 bbl per day, close to the high point reached in the winter. Of the total, 44,800 bbl per day will be Saskatchewan crude, with 5000 bbl coming from Manitoba.

Line from Carbon Field to Calgary Is Approved

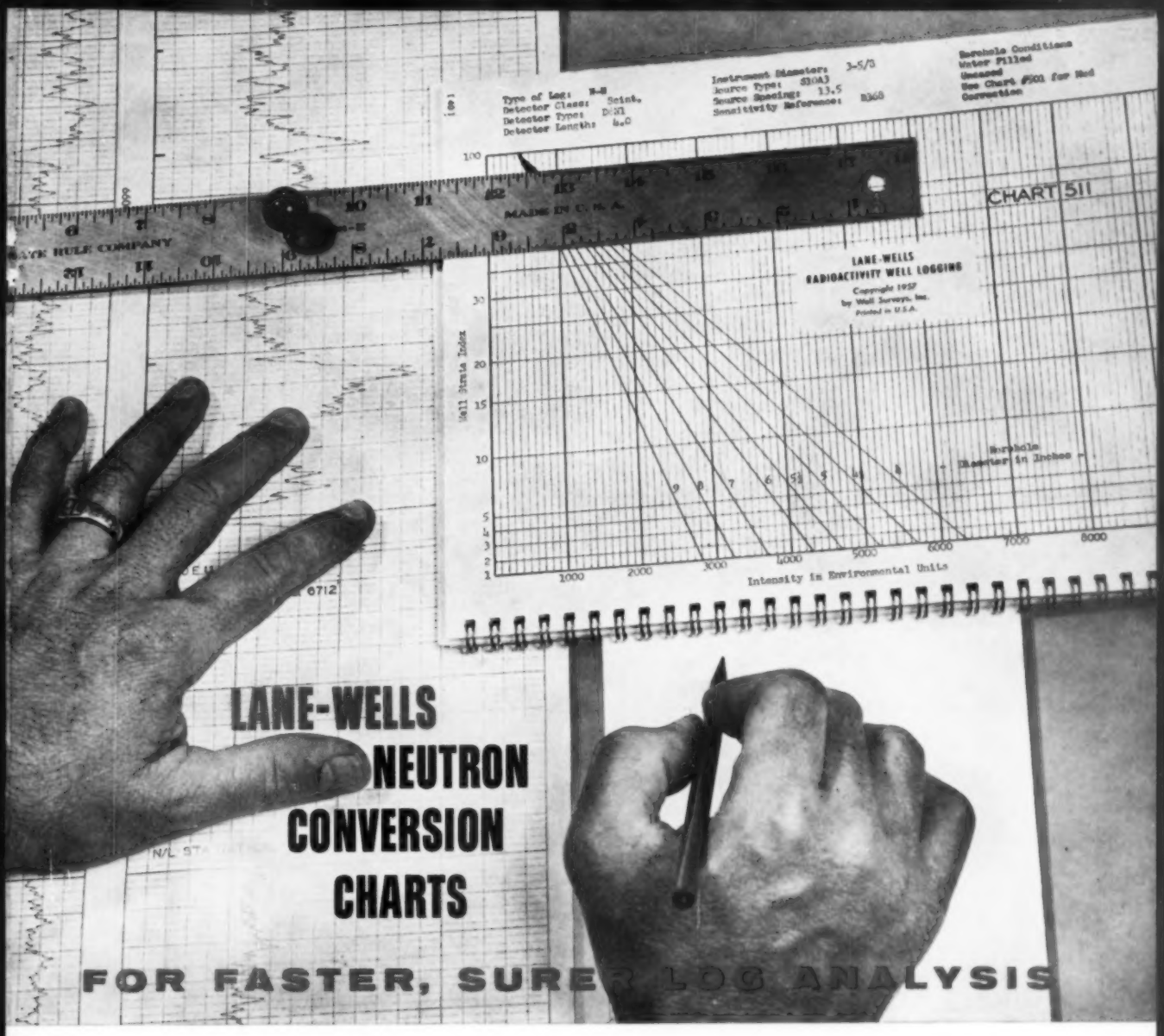
Formal permission has been granted by the Alberta Department of Highways to Canadian Western Natural Gas Company, Ltd., Calgary, to construct a lateral natural gas transmission line from the Carbon gas field to the city gate. Plans for the line were announced several months ago, but construction could not be started until the formal approval. Completion is scheduled for the early fall, with the company's own crews doing the work.

The line will consist of 58.8 miles of 16-in. pipe and the job will cost approximately $2,800,000. The flow through the line from the Carbon field will be used to provide supplemental supply for peak day requirements in the city of Calgary next winter.

PELICAN SUPPLY CO. INC.
P. O. Drawer 1108 Shreveport (84), La.
SEE YOUR NEAREST SUPPLY HOUSE
(Formerly: Pelican Well Tool & Supply Company)

MOLE
Pipeline
Cleaner

for BETTER cleaning of
CRUDE LINES
PRODUCT LINES
NATURAL GAS LINES
FOR DETAILS WRITE
Pipeline Cleaners Co.
Fort Madison, Iowa

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Just consider the advantages of being able to convert incompatible open-hole log data to accurate, common units for equation and comparison. That's the problem attacked by Lane-Wells technicians, and the new Neutron Curve Conversion Charts are the result. With them, you can:

1. Convert the neutron response of any well to another well condition.
2. Convert several different neutron curves to a common basis for direct comparison.
3. Convert dissimilar neutron-response calibrations to comparable units.
4. Establish a comparative measure of porosity (Well Strata Index) that is independent of the type of instrument or bore hole condition.

Along with other advantages, this ready conversion of hybrid data to comparable units is an aid to Quantitative Interpretation—Lane-Wells' method of radioactivity log analysis that tells you "how much" as well as "where." Because they are based on sharp, *repeatable* neutron curves, QI analyses have proved accurate within commercially useful limits in many thousands of locations.

Wherever you operate, the new Conversion Charts can simplify your job of log analysis. Ask your Lane-Wells man for complete details.

LANE-WELLS COMPANY

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While man's ingenuity is expanded into space itself, the continuity of civilization will come from unlocking energy-making materials deep within the earth's vaults.

Halliburton will continue to stand as a working partner in the recovery of these vital force-materials . . . helping to tap subsurface reservoirs for the energy of oil and gas necessary to the needs of man on earth . . . and beyond.

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